Siemens
cf-Level measuring Setup

CARRIER-FREQUENCY LEVEL MEASURING SETUP 10 KC/S TO 17 MC/S

-12 to +2 N • Type Rel 3 W 518d1../D 335d1.., e1..
-110 to +20 db • Type Rel 3 W 518d2../D 335d2.., e2..
-100 to +30 dbm • Type Rel 3 W 518d3../D 335d3.., e3..
-11 to +3 Nm • Type Rel 3 W 518d4../D 335d4.., e4..

Description • Instructions for Use • Notes on Maintenance

Description

I. Application 1
II. Electrical Data 4
III. Function and Layout 9
IV. Accessories, Dimensions, and Weights 32

Instructions for Use

I. Preparation 1
II. Layout of the Measuring Setup 3
III. Calibrating and Setting 4
IV. Measuring 7
V. Annexed Figures 13

Notes on Maintenance

I. Tube Replacement 1
II. Realigning the Frequency Scales 3
III. Replacing the Indicating Lamps 4

The figures in this brochure will suffice in general for the Description and Instructions for Use of the setup. The circuit diagram section brings detailed circuit information reference to which is made in the text by designations such as Rel str ... Rel ms ...; the Notes on Maintenance section contains recommandations for preventive, routine maintenance work.

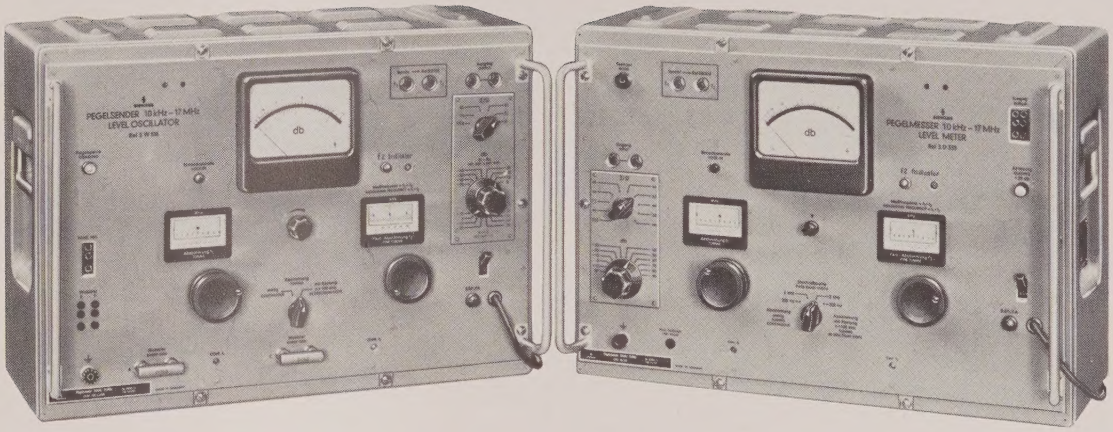


Fig. 1 Carrier-frequency level measuring setup
10 kc/s to 17 mc/s · Type Rel 3 W 518c2a/D 335c2a

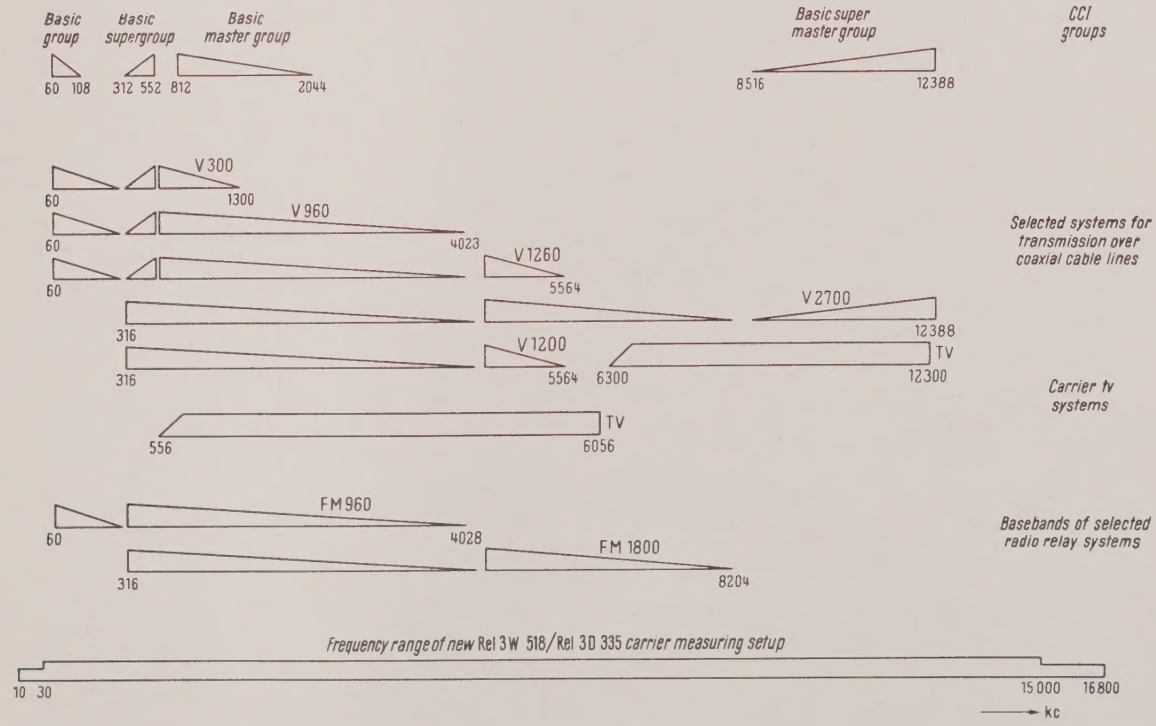


Fig. 2 Diagram of wide line frequency bands; basebands, and CCI groups within the frequency range of the level measuring setup

D E S C R I P T I O N

I. APPLICATION

The level oscillator Type Rel 3 W 518 and the level meter Type Rel 3 D 335 are the basic units of a flexible measuring setup designed for use with carrier equipment (Fig. 1). Its frequency range extends from 30 kc/s to 15 mc/s, or from 10 kc/s to 17 mc/s if slightly wider tolerances are allowed, and includes the transmission bands of multichannel carrier telephone systems for coaxial cables and radio links, the TV program carrier band, the CCITT-recommended groups and basic groups (120 and 60 voice channels) as well as the master and supermaster groups (300 and 900 channels)(Fig. 2), with enough margin left.

A special advantage of the setup is the high accuracy and stability with which the oscillator frequency is transmitted and received. This is achieved by crystal-controlled frequency spectrum facilities and a likewise very precise fine frequency control system. In many cases special frequency meters can be dispensed with due to the high absolute accuracy and the good setting possibility.

The wide measuring range of 130 db (14 N) also allows the measurement of crosstalk attenuation and signal-to-distortion ratio. The high selectivity, the high image-frequency rejection and the low residual distortion of the level meter assure a maximum of measuring accuracy as well as an ambiguous relation between frequency and indication.

If generator and detector are located at the same place of measurement, all selective measurements, owing to the automatic tuning system of the coarse and fine control of the level meter, can be carried out as easily and rapidly as wideband measurements.

Its relatively small volume of equipment, easy operation, and high measuring accuracy give the setup a preferred place in the development of new carrier equipment and systems. A great advantage in the test room is that it helps save a great deal of time in individual and serial tests. Finally, simple and functionally arranged controls facilitate the line-up and alignment of transmission paths as well as their in-service maintenance.

In addition, the level meter, owing to its well-defined bandwidth and RMS response, can also be used for noise level measurements.

Practical evaluation on the various carrier systems revealed such an excellent netting accuracy of the setup and stability of the level meter that it can be employed e.g. for measuring the pilots that the pilot level oscillator Type Rel 3 W 65 has injected into the gaps between the supergroups of the carrier systems. Such a "pilot level measuring setup", in conjunction with recording equipment, is also suited for permanent supervision.

The level oscillator can be amplitude-modulated with signals of the frequency 0 to 100 kc/s from an external source. The envelope distortion remains low even with high modulation percentages.

The devices are supplied with neper or decibel calibration. Moreover, there are models whose calibration for the built-in terminations is refered

to 1 mw (dbm, Nm), in the case of the level meter, independently of whether the internal or an external termination is used. The built-in terminations can be adapted to the respective requirements. For connecting balanced specimens (up to 1 mc/s) the balancing transformer Type Rel 3 B 216 is available. Signal-to-reflection ratios can be measured with the aid of the small-size reflection coefficient measuring bridge Type Rel 3 R 132.

Measurements at high-impedance points (e.g. on lines terminated into Z without bridging loss) can be made with the probe Type Rel 3 B 938.

The models Type Rel 3 D 335e1 to e4 differ from the models d1 to d4 in that the range switches are arranged in a different way, so that the most favorable S/N ratio is even more easily attainable.

The mechanical layout is adapted to the slide-in chassis design according to DIN 41490 (size A 1'8^{1}/2"x1'1^{3}/8"x7^{1}/8" or 520x338x180 mm). The portable models (with the affixes d1a to d4a, e1a to e4a) are slid into rugged light-metal casings, the rack-mounting models (with the affixes d1b to d4b; e1b to e4b) are provided with slide-on covers and can be used with each bay that corresponds to the basic dimensions according to DIN 41490, sheet 1, page 3.

By a sweep-frequency attachment and a level tracer the measuring setup can be expanded to a sweep-frequency measuring setup handling all measuring problems that occur in this frequency range. The automatic tuning system assures that all advantages of selective measurements are retained in swept operation, too.

II. ELECTRICAL DATA

Level Oscillator

Frequency Range . . . . . 10 kc/s to 17 mc/s

Scale control f_1

in 100-kc/s spectrum steps . . . . . 0 to 17 mc/s

when the frequency spectrum facilities are disabled, continuously between . . . . . 0 and 17 mc/s

Scale control f_2, continuously between . . . . . -10 and +100 kc/s

Minimum readable frequency increment . . . . . approx. 200 c/s

Frequency error (after zero cycle calibration and with spectrum-step tuning) . . . . . $\pm 2 \times 10^{-5}$ ± 300 c/s

With variations of the mains voltage of ±10 %, the locked frequency varies by . . . . . $\pm 1 \times 10^{-6}$ ±30 c/s

Automatic tuning system, control voltages for the level meter Type Rel 3 D 335:

Control frequencies at the output "Synchr.f_1" . . . . 21.1 to 38.1 mc/s

Control frequencies at the output "Synchr.f_2" . . . . . 310 to 200 kc/s

	Calibration in: decibel, models 2a (dbm, models 3a)	neper, models 1a (Nm, models 4a)
Output level, as referred to the zero mark on the instrument, can be set in steps of 10 db (1 N)		
for $Z_i \approx 0\ \Omega$	-60 to +10 db	-6 to +1 N
for $Z_i = Z$	-70 to 0 db (-60 to +10 dbm)	-7 to +0 N (-6 to +1 Nm)
Intermediate values can be set		continuously
Minimum settable level		
for $Z_i \approx 0\ \Omega$	-80 db	-8 N
for $Z_i = Z$	-90 db (-80 dbm)	-9 N (-7 Nm)
Error of the output level at the reference values of 1 mc/s and 0 db, 0 N (+10 dbm +1 Nm)	±0.2 db	±0.02 N

	Calibration in: decibel, models 2a (dbm, models 3a)	neper, models 1a (Nm, models 4a)
Additional error introduced by attenuator		
up to 10 mc/s	±0.3 db	±0.03 N
up to 15 mc/s	±0.5 db	±0.05 N
up to 17 mc/s	approx. ±1 db	approx. ±0.1 N
Frequency response of the output level without readjustment		
up to 10 mc/s	±0.3 db	±0.03 N
up to 15 mc/s	±0.5 db	±0.05 N
up to 17 mc/s	approx. -3 db	approx.-0.35 N
With mains voltage variations of ±10 %, the output level varies by	approx. ±0.3 db	approx.±0.03 N
Signal-to-distortion ratio a_{k2}, a_{k3} when the instrument is set to the zero mark		
for f_m up to 10 mc/s	≧ 40 db	
for f_m between 10 mc/s and 17 mc/s	approx. 30 db	
when the instrument is set to the -10-db (-1-N) mark and for f_m up to 15 mc/s	≧ 40 db	
The rejection of higher-order harmonics is still better		
Spurious emissions are	approx. 50 db down	
Source impedance, can be switched		
Models 1a (N) and 2a (2b)	0; 50; 60, 65, 75, 150 (135+) Ω	
Models 3a (dbm)	0; 65, 75, 135, 140, 150 (125+) Ω	
Models 4a (Nm)		0; 75, 150 Ω
Reflection coefficient at the output Z = 75 Ω in the measuring ranges -7 to -1 N, -70 to -10 db, -60 to 0 dbm, -6 to 0 Nm		
and up to 15 mc/s		r < 0.05
up to 17 mc/s		r < 0.08

+ upon request, instead of 150 Ω.

External modulation (AM)

Frequency range . . . . . 0 to 100 kc/s

Modulation percentage . . . . . 0 to 100 %

Frequency response up to 30 kc/s . . . . . approx. ±2 %

Envelope distortion at

m = 30 % and carrier f = 1 mc/s . . . . . approx. 40 db down

Required modulation voltage for

each percent of modulation . . . . . approx. 40 mv

Power supply . . . . . 110, 130, 220 (230), 240 v ±10 %; 48 to 60 c/s; approx. 120 va

Selective Level Meter

Frequency range . . . . . 10 kc/s to 17 mc/s

Scale control f_1

in 100-kc/s spectrum steps . . . . . 0 to 17 mc/s

when the frequency spectrum facilities

are disabled, continuously between . . . . . 0 and 17 mc/s

Scale control f_2, continuously between . . . . . -10 kc/s and +100 kc/s

Minimum readable frequency difference . . . . . approx. 200 c/s

Frequency error (after calibration and with

spectrum-step tuning) . . . . . $\pm 2 \times 10^{-5}$ ±300 c/s

With variations of the mains voltage of

±10 %, the locked frequency varies . . . . . $\pm 1 \times 10^{-6}$ ±30 c/s

	Calibration in: decibel, models 2a (dbm, models 3a)	neper, models 1a (Nm, models 4a)
Measuring range, as referred to the zero mark on the instrument, can be switched in steps of 10 db (1 N) each	-100 to +20 db (-90 to +30 dbm)	-11 to +2 N (-10 to +3 Nm)
Minimum measurable level	-110 db (-100 dbm)	-12 N (-11 Nm)
Minimum readable level with the input impedance equal to Z and a pass band of 200 c/s, between 30 kc/s and 17 mc/s . .	-125 db (-115 dbm)	-14 N (-13 Nm)

	Calibration in: decibel, models 2a (dbm, models 3a)	neper, models 1a (Nm, models 4a)
between 10 and 30 kc/s	-115 db (-105 dbm)	-13 N (-12 Nm)
with a pass band of 2 kc/s between 30 kc/s and 17 mc/s	-115 db (-105 dbm)	-13 N (-12 Nm)
Measuring error at 1 mc/s and 0 db, 0 N, +10 dbm +1 Nm, ...	±0.2 db	±0.02 N
Error introduced by input attenuator as referred to the position 0 db, 0 N, +10 dbm, +1 Nm,		
at 1 mc/s	±0.1 db	±0.01 N
up to 10 mc/s	±0.3 db	±0.03 N
up to 15 mc/s	±0.5 db	±0.05 N
Frequency response within one position of the input attenuator		
between 30 kc/s and 10 mc/s	±0.2 db	±0.02 N
between > 10 kc/s and 15 mc/s	±0.3 db	±0.03 N
Drop at 17 mc/s	approx. 3 db	approx. 0.35 N
Additionally, when the luminous turnkey "Reading -20 db, -2 N" is down (models d1a to d4b)	±0.2 db	±0.02 N
With mains voltage variations of ±10 %, the reading varies by	±0.2 db	±0.02 N

Selectivity, can be switched

Wideband:

Frequency range . . . . . 30 kc/s to 17 mc/s

Pass band width $\triangle a \leq 0.2$ db, 0.02 N . . . . . f_m ±300 c/s

$\triangle a \leq 0.5$ db, 0.05 N . . . . . f_m ±800 c/s

Bandwidth $\triangle a = 3$ db, 0.35 N . . . . . approx. 3.1 kc/s (corresponds to the width of a voice channel)

Stop band loss at f_m ±4 kc/s . . . . . approx. 60 db (7 N)

Narrow band:

Frequency range . . . . . 10 kc/s to 17 mc/s

Pass band width (Δa < 0.5 db, 0.05 N) . . . . . 200 c/s

Stop band loss at $f_m \pm 1$ kc/s . . . . . approx. 35 db (4 N)

at $f_m \pm 2$ kc/s . . . . . approx. 52 db (6 N)

Intermediate frequencies . . f_{z1} = 21 mc/s; f_{z2} = 1.5 mc/s; f_{z3} = 50 kc/s

f_{z4} (at the output jacks) = 3 kc/s

Image-frequency rejection

of $f_m + 2f_{z1}$ . . . . . approx. 60 db (7 N)

of $f_m + 2f_{z2}$, $f_m + 2 f_{z3}$ . . . . . approx. 74 db (8.5 N)

of $f_m + 2f_{z4}$ . . . . . approx. 60 db (7 N)

Attenuation of a signal with respect to one of the intermediate frequencies f_{z1} to f_{z4} at the input . . . . . approx. 80 db (9 N)

Residual distortion a_{k2} and a_{k3} when the sensitivity is increased by 50 db (6 N) . . . . . $\geq$ 65 db (8 N)

Input impedance . . . . . "high"

corresponding to an input capacitance of . . . . . approx. 40 pf

Can be switched to the nominal values

with model 1 . .(N) . . . . . 50, 60, 65, 75, 150 Ω

with model 2 . .(db) . . . . . 50, 60, 65, 75, 150 (135+) Ω

with model 3 . .(dbm) . . . . . 65, 75, 135, 140, 150 (125+) Ω

with model 4 . .(Nm) . . . . . 75, 150 Ω

Reflection coefficient of the input (Z = 75 Ω)

up to 10 mc/s . . . . . r $\leq$ 0.03

up to 15 mc/s . . . . . r $\leq$ 0.05

Power supply . . . . . 110, 130, 220 (230), 240 v ±10 %; 48 to 60 c/s; approx. 100 va

+ upon request, instead of 150 Ω

III. FUNCTION AND LAYOUT

A. Level Oscillator Type Rel 3 W 518

The level oscillator is of the beat-frequency type and covers the entire frequency range between 30 kc/s and 15 mc/s or, when the tolerances are somewhat extended, between 10 kc/s and 17 mc/s, on a single, approximately frequency-linear scale without range switching. Fig. 3 shows that the outputs of the oscillator units G1 and G2 are applied to a ring modulator Md1, whose output delivers a voltage that essentially contains the sum and difference frequencies of f_1 and f_2. The following 17-mc/s low-pass filter selects the component with the difference frequency. After sufficient amplification of the useful signal which is initially low, and indication of its level, the signal is applied via the measuring panel to the output.

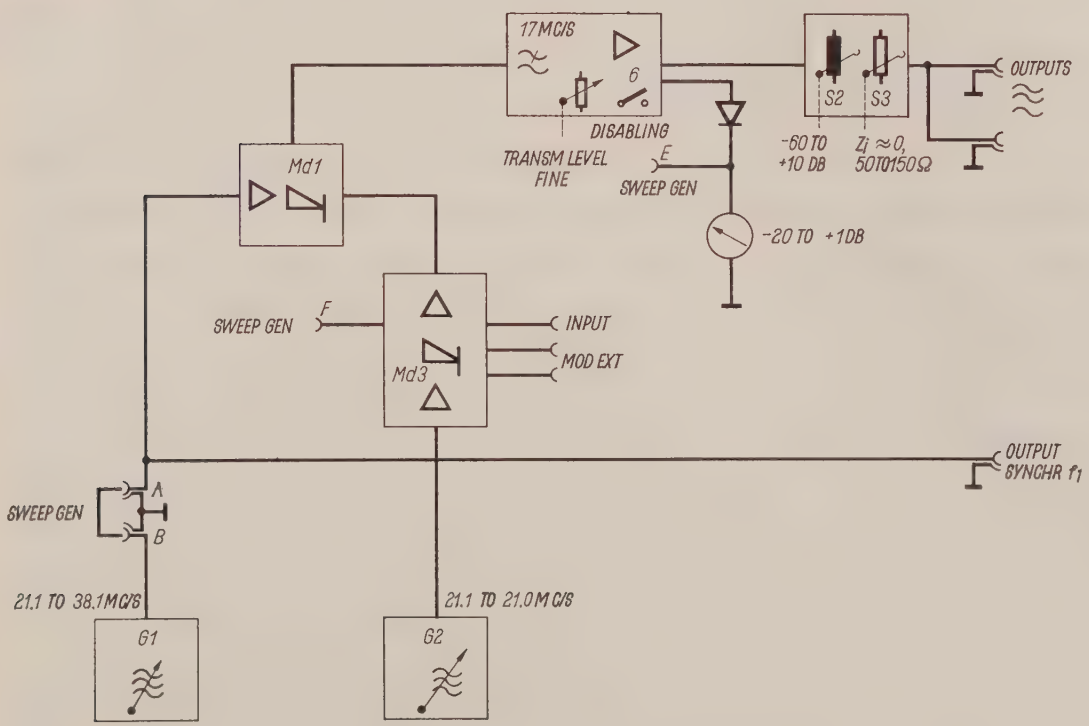


Fig. 3 Functional circuit diagram of the level oscillator

Oscillator Units G1 and G2

The variable-frequency oscillator unit G1 works in the frequency range f_1 = 21.1 to 38.1 mc/s and generates the carrier voltage for modulator Md1. The oscillator unit G2 with the frequency f_2, which can be adjusted between 21.1 and 21.0 mc/s supplies a constant signal voltage.

The error of the output frequency is directly determined by the sum of the frequency variations of the two oscillator units. High frequency accuracy and stability of the oscillator units have already been achieved by careful selection of their components, such as ceramic coils with evaporated silver turns, the use of crack-free mica capacitors and high-grade variable precision capacitors. The optional connection of frequency spectrum facilities in the variable-frequency oscillator unit G1, which provide for automatic frequency adjustment to a crystal-stabilized comparison frequency, and a frequency-controlling circuit arrangement in the fixed oscillator unit G2, which is fundamentally similar to that outlined above, succeeds in improving the frequency stability at the beat-frequency output to such an extent that it equals that of a crystal generator, although the beat-frequency oscillator can be continuously tuned through a range of 1 : 1700.

The frequency spectrum facilities in the oscillator unit G1 (Fig. 4) assure an exact and rigid locking of the oscillator frequency (21.1 to 38.1 mc/s) to the 211th to 381st harmonic of a 100-kc/s crystal oscillator. The frequency of the oscillator has thus crystal accuracy every 100 kc/s.

The sinewave signal of the oscillator unit G1 to be controlled and a narrow 100-kc/s pulse are applied to the mixer Md2. This pulse is derived from the sinewave signal of the crystal oscillator G10 by waveform shaping into a pulse. At the output of the mixer there appears again a pulse-shaped signal of the repetition frequency of 100 kc/s, its peak value depending on the respective instantaneous value of the sinewave oscillator voltage with which the narrow input pulse coincides in time, i.e. the magnitude of the peak value is determined by the phase difference between oscillator and spectrum voltage. The output voltage of the mixer is first amplified, then rectified and selected (by a 50-kc/s low-pass filter). This phase-dependent DC voltage is applied as a regulating voltage to the reactance network RG1 located in the resonant circuit of oscillator unit G1. Thus controlled, the reactance network automatically changes

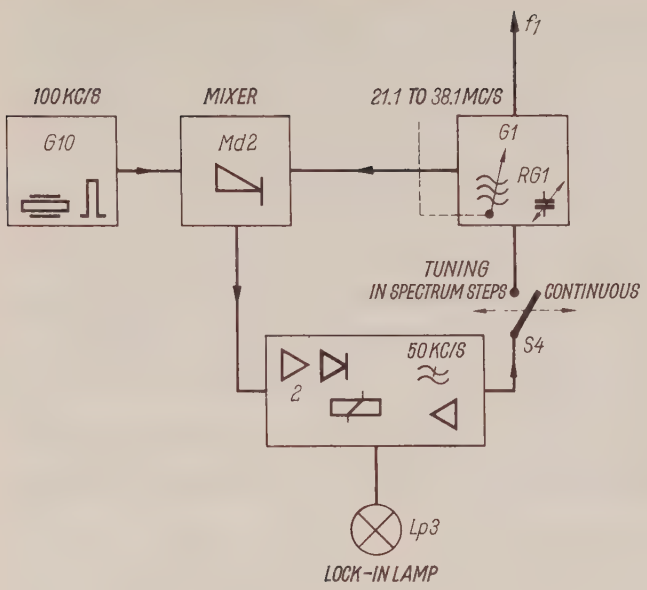


Fig. 4 Functional circuit diagram of the lock-in oscillator unit G1

the manually set oscillator frequency until it locks exactly to the desired integral multiple of 100 kc/s in a kind of "electronic detent".

This readjustment is secured as long as the difference between the phase angles remains within $\pm 90^{\circ}$. Within these limits, the tuning capacitor has a "holding range" within which the frequency remains completely constant. Only the relative phase with respect to the spectrum voltage changes. Outside this holding range the oscillator runs freely at a frequency that is between two 100-kc/s spectrum steps, the frequency of G1 being no longer an integral multiple of 100 kc/s. The consecutive narrow 100-kc/s pulses will therefore coincide with different instantaneous values of the sinewave voltage of G1, which at the mixer output, results in a composite-frequency wave that is superimposed, in the form of an envelope, on the pulse-shaped 100-kc/s voltage. Since this composite-frequency wave must always include a frequency of $\leq$ 50 kc/s, a corresponding AC voltage is applied through the low-pass filter to the reactance network, so that oscillator G1 is frequency-modulated (swept operation). When the tuning capacitor is further advanced, the center frequency of G1 will very soon approach the next spectrum frequency and the oscillator is automatically pulled in because of the superimposed frequency deviation, and it locks exactly to the new spectrum line.

When the frequency is locked to a spectrum step, there will thus appear at the output of the 50-kc/s low-pass filter merely a DC voltage, while when the frequency is not locked, an AC voltage appears in addition. This difference is evaluated in a circuit arrangement consisting of amplifier, rectifier, and relay for controlling the indicating lamp Lp3.

When the frequency spectrum facilities are activated, the variable-frequency oscillator unit G1 will supply a voltage usable for heterodyning only every 100 kc/s, but with crystal accuracy. However, it is possible to set values between the multiples of 100 kc/s by continuously varying the "fixed" oscillator unit G2 by $\triangle f = 0$ to 100 kc/s. The frequency accuracy and stability of G2 should simultaneously equal the crystal accuracy of G1 as largely as possible.

This and other conditions can readily be fulfilled with the aid of an "interpolation system" (Fig. 5).

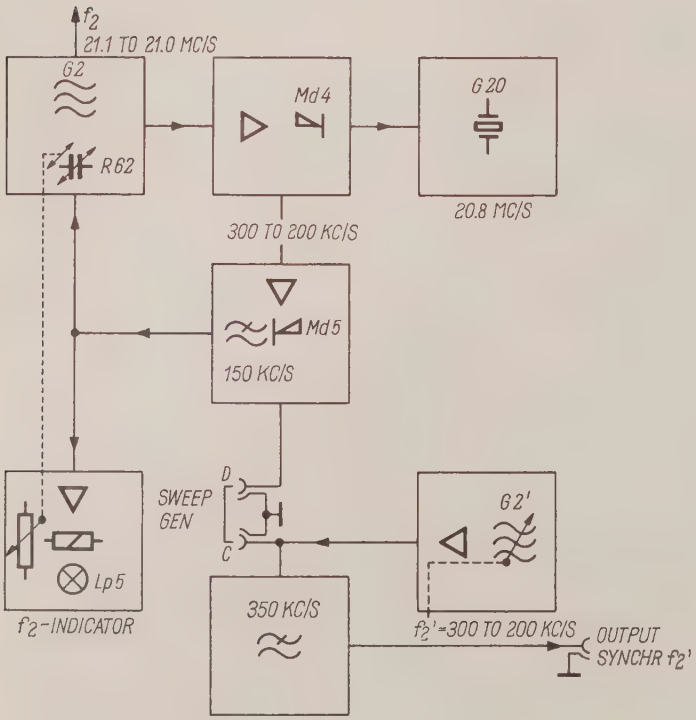


Fig. 5 Functional circuit diagram of the interpolation oscillator

In modulator Md4 the frequency of oscillator unit G2 (21.1 to 21.0 mc/s) is translated to a low intermediate frequency between 200 and 300 kc/s with the aid of the frequency of the crystal-controlled oscillator unit G20 (20.8 mc/s). Via a two-stage R-C amplifier, the IF signal is applied to modulator Md5, which functions as a phase bridge comparing the difference frequency of G2 and G20 with the frequency of an oscillator unit G2', which can be varied between 300 and 200 kc/s with the variable capacitor "Fine Tuning f_2". If the frequencies applied to the phase bridge agree exactly, a zero-cycle frequency will appear at its output as the difference frequency, i.e. a DC voltage, whose magnitude and polarity depend on the relative phase positions of the two reference voltages. The residual carrier and the sum frequency are suppressed by a low-pass filter. This regulating voltage controls the diode used as reactance RG2, whose change in capacitance corrects the frequency of oscillator unit G2. When the frequency of the auxiliary oscillator is changed, this causes initially a change in the relative phase positions of the comparison voltages in modulator Md5. As a consequence of this, the regulating DC voltage varies, thereby controlling the frequency of G2 via the reactance network so that the frequencies of the comparison voltages and hence of the generators agree again. Lamp Lp5 of indicator f2 lights up then. The operating point of the reactance network RG2 can be readjusted with the potentiometer R2 by changing the bias. The accuracy of frequency f2 is determined by f20 and f2'. Since f2' is only about 1/100 of f20, the crystal accuracy of f20 is achieved for all practical purposes.

The output voltage of the variable-frequency oscillator unit G1 is applied to the ring modulator Md1 in the form of the carrier voltage via a buffer amplifier. The oscillator unit G2 furnishes the signal voltage, which is previously amplified for stabilization via a limiter, since it determines the amplitude of the modulator output voltage.

Between the output of this amplifier and the modulator Md1 there is also interposed the external modulation equipment, which, by the application of an external voltage, allows amplitude modulation in the frequency range of 0 to 100 kc/s with modulation percentages up to 100 % and low envelope distortion. It consists of a ring modulator (Md3) with subsequent carrier addition. The stabilized signal voltage from G2 forms the carrier voltage for this modulator, while the modulating audio voltage is supplied by the external signal applied to the input "Mod. Ext.". Upon application of a

modulation voltage, only the two side frequencies appear at the output of the modulator. From G2, the signal voltage is subsequently added with correct magnitude and relative phase. For this purpose, both the input and output of the modulator are connected to a corresponding R-C network.

The modulator Md1 is designed as a ring modulator. Both the signal voltage and the carrier voltage are applied to the modulator ring via separate transformers with balanced secondary. The modulation ratio (E1 : E2) has been so selected that interfering voltages in the band of useful frequencies remain negligibly small. The modulation product is taken from the center taps of the secondaries for application to the following low-pass filter.

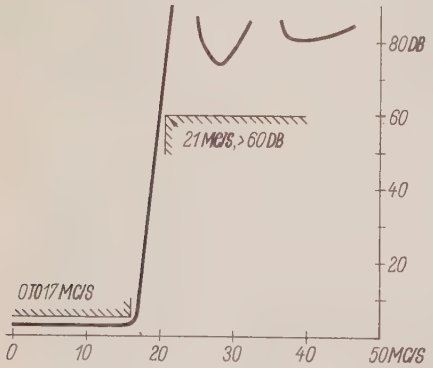


Fig. 6 Amplitude/frequency response of the 17-mc/s low-pass filter in level oscillator and level meter

This low-pass filter (cutoff frequency f_g = 17 mc/s) effectively suppresses the residual carrier, the high-order mixing products as well as all interfering signals above the useful band. Fig. 6 shows the attenuation-vs.-frequency curve of this filter, which is designed as a steepened four-section network with a characteristic impedance of Z = 200 Ω and a distortion in the pass band of ±0.2 db. At frequencies $\geq$ 21 mc/s the stop band loss is better than 60 db.

The low transmitting voltage now available at the output of the filter is applied to a potentiometer for continuous fine adjustment and then to a wideband amplifier. The output of this six-stage amplifier is capable of delivering a voltage level up to +10 db[+] with an external termination of $\geq$ 50 Ω, with only a few percent of frequency response over the entire frequency band and a low distortion factor. The amplifier consists of

[+] This figure and the following data apply analogously to the device calibrated in N, dbm, and Nm

preamplifier and final amplifier. The preamplifier contains two cascode stages with R-C coupling and a cathode follower stage at the output end, which is degeneratively coupled for linearization and stabilization. Upon depression of key T1 "Disabling" the anode voltage of the first stage (tube 4) is interrupted and hence the transmitting level disconnected. Repeated short interruptions of the transmitting level results e.g. in a characteristic signal that facilitates the identification of the test signal in a complex-frequency wave at the receiving end.

The final amplifier also employs voltage degeneration and contains a cascode stage and a pushpull final stage. For DC operation the two final stages are cascaded, but in AC applications they are run in push-pull operation. This arrangement assures inherently a low source impedance at the output end which is further reduced to about 10 Ω by voltage degeneration. The wideband output transformer with its turns ratio of ü = 3 : 1 transforms the source impedance to about 1 Ω at mid-band. Owing to the stray inductance of the output transformer the impedance increases to some ohms at high frequencies.

The following measuring field contains a switched voltage divider composed of transformers. It serves to set the output level in steps of 1 db. Another switch permits the source impedance to be set to the various Z-values. Like the rest of the units of the device - the wideband amplifier exclusively employs the communications-type tube CCa (E88CC). In each amplifier stage the two triode sections of a tube CCa are connected in series to the anode voltage E_A = 215 v. In order to reduce the dependence on heater and anode voltage changes, relatively high cathode resistances of 1 to 2 kΩ have been chosen. The grid bias is stabilized with silicon Zener diodes before being separately applied to the individual stages.

For connection of the sweep-frequency attachment Type Rel 3 W 933 to the level oscillator provision has been made for break jacks "Sweep Gen." that are short-circuited via coaxial connectors for manual control. The sweep-frequency attachment supplies jack A with the voltage from the sweep-frequency oscillator. At jack B the voltage of G1 is available for generating crystal-accurate frequency markers. If the sweep-frequency attachment contains the slide-in chassis for narrow sweeps, the jacks C-D serve for connection to the oscillator end G2. The jacks E and F are intended for connection of the automatic level control system. From jack E of the detector circuit a DC voltage is taken to be passed via a regulating

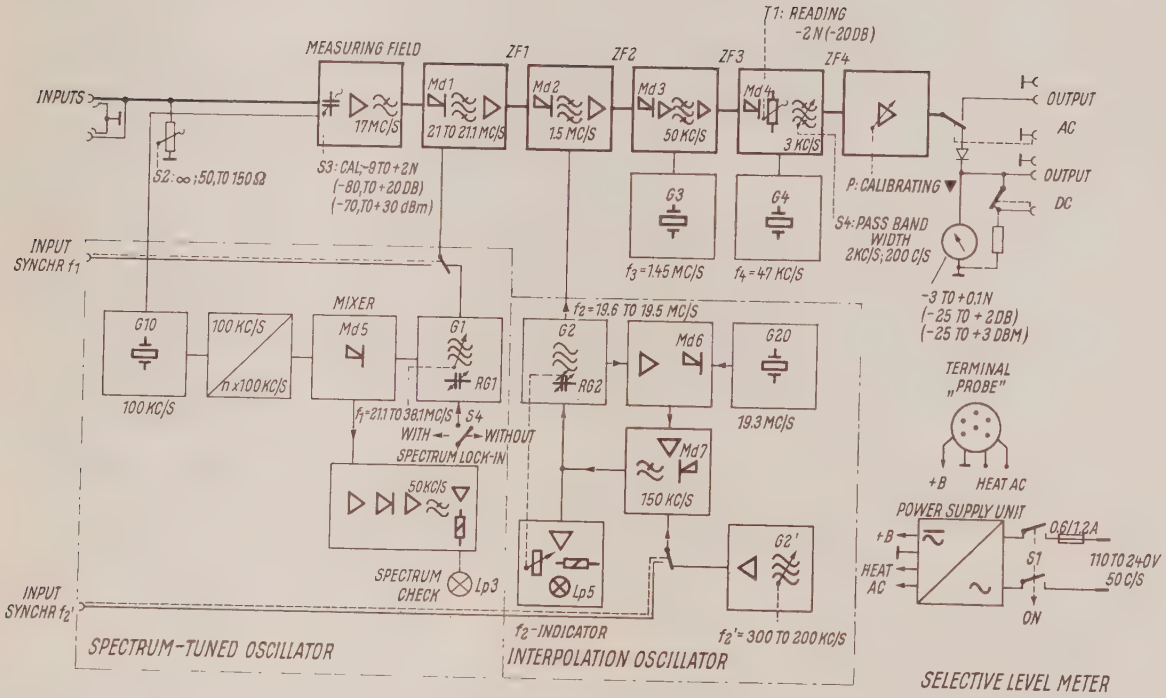


Fig. 7 Functional circuit diagram of the level meter

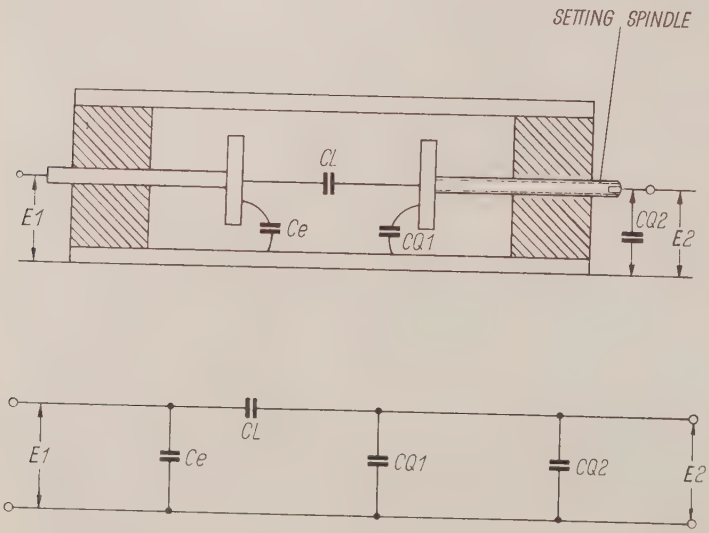


Fig. 8 Schematical layout and equivalent circuit of the waveguide-beyond-cutoff attenuator

amplifier in the sweep attachment and applied to the jacks F. It is thus applied as a modulating voltage to modulator Md3 and controls the amplitude of the signal voltage from G2.

B. Level Meter Type Rel 3 D 335

The level meter is a heterodyne detector laid out for the special requirements of carrier transmission engineering. Its frequency range equals that of the level oscillator Type Rel 3 W 518, i.e. extends from 10 kc/s to 17 mc/s.

In four frequency translations the voltage under test is brought to a last intermediate frequency in the audio range (3 kc/s) before being applied to the detector circuit or the (detector) output jack. The characteristics of the heterodyning oscillator units G1 to G4 determine the accuracy and stability of the tuning. For this reason the variable-frequency oscillator units G1 and G2 are provided with frequency spectrum facilities and interpolation equipment similar to those of the level oscillator. The generators G3 and G4 are crystal-controlled. For detecting unknown frequencies or exploring frequency spectra the level meter can be continuously tuned. Maximum frequency accuracy can be achieved by activation of the frequency spectrum facilities. Frequencies between two adjacent spectrum steps (n x 100 kc/s) can be continuously set with the interpolation oscillator G2.

As the basic circuit diagram of the level meter (Fig. 7) shows, that it is possible to replace the oscillator units G1 and G2' by the corresponding oscillator units of the level oscillator via the inputs "Synchr.f1" and "Synchr.f2". This simplifies the operation considerably, since the detector is automatically tuned to the level oscillator frequency.

The input impedance of the device is high and capacitive ($C \approx 40$ pf). It is possible to bridge across the input incorporated terminations between 50 and 150 Ω with switch S2. With the same switch the corrective term of $\sqrt{Z/600\ \Omega}$ is introduced with the level meters in direct power level measurements (as referred to 1 mw, dbm). In this case the switch has two positions: one for a high-impedance input and another for an input terminated into Z.

The measuring voltage is first applied to the function switch S3 (see Rel str 3 D 335). By means of the steps of the two decks of this switch, another capacitive attenuator (with a 20-db increase in each case is switched into circuit in each alternate step. In the intermediate steps, switch S3 controls relay A, which connects into circuit a resistive 10-db attenuator after the preamplifier. To avoid capacitive couplings, the attenuators not required at the time are grounded by short-circuiting prongs of switch S3.

The capacitive attenuators are designed according to the principle of a waveguide attenuator, since only this configuration secures the required extremely low series-arm capacitances C_L (Fig. 8). The series-arm capacitance for the 80-db attenuator is 0.01 pf, for instance. The attenuation ratio is determined by the series-arm capacitance C_L and the shunt-arm capacitances C_{Q1} and C_{Q2}. Provided that the electrode spacing of a waveguide attenuator is greater than one fourth of its diameter, the logarithm of its attenuation ratio increases linearly with the electrode spacing. For this reason such waveguide attenuators provide the advantage that all attenuation values can be adjusted with the same degree of accuracy. The shunt-arm capacitances of all attenuators are equal (100 pf) so that the input capacitance of the following amplifier controls all attenuators in the same way.

The preamplifier following the attenuator is a degenerative R-C amplifier with two tubes CCa. In the frequency range 10 kc/s to 17 mc/s it provides constant gain and low distortion. The first stage of the amplifier is a cascode circuit, while the second is laid out as an unbalanced pushpull circuit. Its voltage gain of 12 db compensates for the voltage decrease up to modulator Md1 inclusive of the interposed image-frequency rejection filter (17-mc/s low-pass filter), which is of the same design as the low-pass filter in the level oscillator (see Fig. 6 for the attenuation-vs.-frequency curve). Modulator Md1 consists of a ring modulator and two differential transformers.

The spectrum oscillator supplies the carrier voltage of the frequency f_1 (21 to 38.1 mc/s) to modulator Md1 via a two-stage carrier amplifier accommodated in the measuring field subassembly. Depending upon the frequency setting on G1 the generated first intermediate frequency f_{z1} may range between 21.0 and 21.1 mc/s. The following band-pass filter,

whose attenuation-vs.-frequency curve is shown in Fig. 9, accepts only this range. For rejecting the image frequency the band-pass filter has an attenuation peak of $a_{sp} \geq 80$ db at f = 18 mc/s.

The two triode sections of the following amplifier are connected as cathode stages and work as impedance transformer. The attenuation of the 1st modulator and that of the 21-mc/s filter are compensated for by two resonant circuits with a voltage step-up. One of the resonant circuits is at the filter output, the other between the two cathode stages. In order to avoid overloading, the voltage applied to modulator Md2 is only a little above that across modulator Md1.

The ring modulator Md2 is supplied with a carrier from the interpolation oscillator unit G2, whose frequency can be varied between 19.5 and 19.6 mc/s. The heterodyning of this frequency with the first intermediate frequency f_{z1}, which is in the range 21.0 mc/s to 21.1 mc/s, results in a signal of fixed frequency f_{z2} = 1.5 mc/s behind modulator Md2. It is selected in the following 1.5-mc/s band-pass filter. The attenuation-vs.-frequency curve of the 1.5-mc/s band-pass filter can be seen from Fig. 10. The attenuation peak at f = 1.4 mc/s serves again for rejecting the image frequency.

Since the input impedance of the band-pass filter is Z_e = 600 Ω and its output impedance Z = 30 kΩ, the voltage gain is 17 db. For matching the high filter output impedance to the low input impedance of the following modulator Md3, a cathode follower designed as an impedance transformer is used.

The ring modulator Md3 translates the second intermediate frequency f_{z2} = 1.5 mc/s to the third intermediate frequency of f_{z3} = 50 kc/s. The heterodyning carrier necessary for this conversion is supplied by the oscillator unit G3 with a frequency of f3 = 1.45 mc/s.

The voltage of the frequency f_{z3} = 50 kc/s is first applied to a degenerative R-C amplifier. In order to achieve constant gain even with fluctuations of the mains voltage, this amplifier is provided with strong DC degeneration in addition to AC (voltage) degeneration. The 50-kc/s band-pass filter determines the bandwidth of the level meter in the position "Pass Band 2 kc/s". Fig. 11 shows that its pass band has been so designed that the attenuation distortion at 50 kc/s ±1 kc/s is 0.5 db.

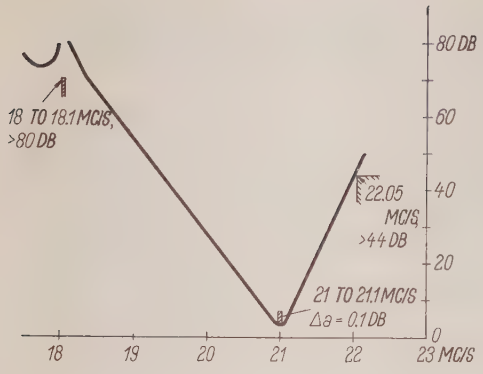


Fig. 9 Attenuation/frequency curve of the band-pass filter for f_{z1}

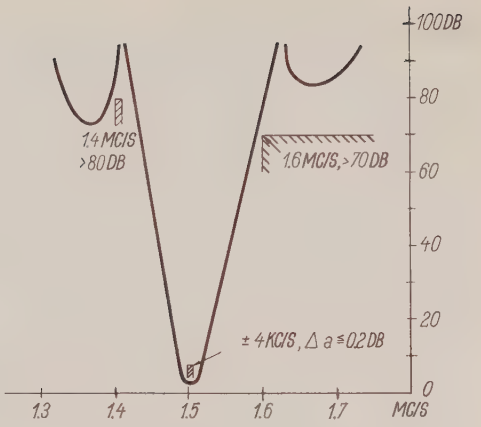
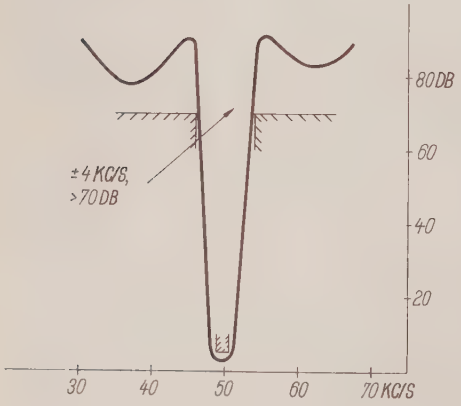
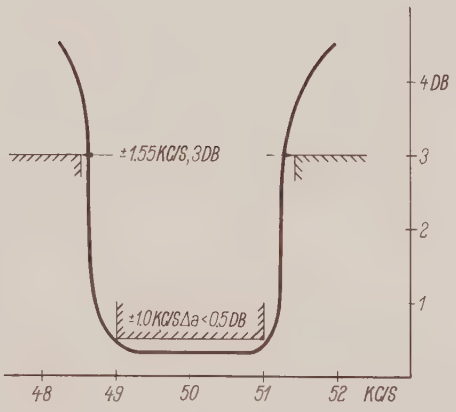


Fig. 10 Attenuation/frequency curve of the band-pass filter for f_{z2}

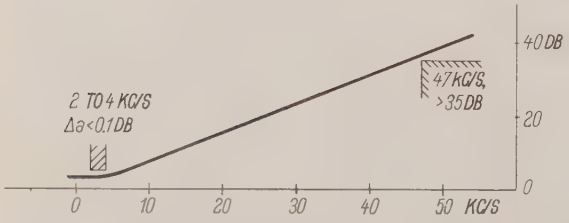


a. Overall curve

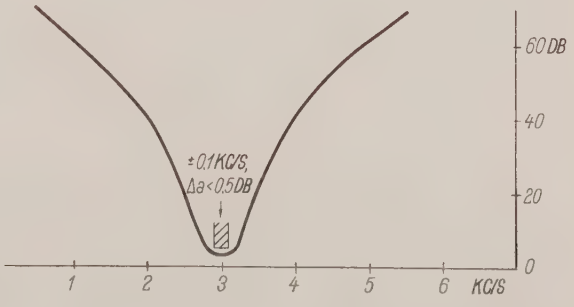


b. Pass band shown expanded

Fig. 11 Attenuation/frequency curve of the band-pass filter for f_{z3}



a. 3-kc/s low-pass filter



b. 3-kc/s band-pass filter

Fig. 12 Attenuation/frequency curve of the filters for f_{z4}

In order for this filter to simulate the width of a voice channel as closely as possible, the bandwidth (Δ a = 3 db) is approximately 3.1 kc/s.

By transformation of the characteristic impedance of the filter 600 Ω/30 kΩ, a voltage gain of approx. 17 db is achieved. The filter termination consists of two resistors, the lower tap corresponding to an attenuation of 10 db. For the most sensitive range (-100 db full-scale deflection) relay B connects the following amplifier direct to the filter output. In all other measuring ranges, the amplifier is connected to the 10-db tap for a good S/N ratio. Hence, the winding of relay B is connected to the supply voltage only in the position "-100 db" of switch S3 in the case of the models "d", and in the position "-30 db" of switch S7 in the case of the models "e". The secondary of the output transformer of the following two-stage R-C coupled amplifier has a differential winding that forms the input for ring modulator Md4.

In modulator Md4 the third intermediate frequency f_{z3} = 50 kc/s is translated to the last intermediate frequency f_{z4} = 3 kc/s. The voltage for the heterodyning carrier with the frequency f4 = 47 kc/s is supplied by oscillator unit G4.

The oscillator units G3 and G4 consist each of a triode section of tube 6 (CCa). Their frequency is stabilized by a crystal, their amplitude by a germanium diode in the degenerative path.

With switch S4, the modulator output voltage can either be connected to the 5-kc/s low-pass filter or to a 3-kc/s band-pass filter. With switch S4, the two filter outputs are alternatively connected to the final amplifier. The 5-kc/s low-pass filter, which is switched into circuit in the position "Pass Band Width 2 kc/s", suppresses the residual carrier and the sum frequency of modulator Md4. The attenuation-vs.-frequency curve of the 3-kc/s band-pass filter ("Pass Band Width 200 c/s") is shown in Fig. 12. The insertion loss of the two filters is aligned to the same value.

Between the output of modulator Md4 and the two 3-kc/s filters a 20-db attenuator is interposed, which secures an optimum S/N ratio. For the measuring ranges -90 and -100 db (full-scale deflection) the attenuator is switched out of circuit with the luminous turnkey T1 "Reading -20 db" (this is indicated by a lamp in the key). This transfer also insures lowest residual distortion of the level meter (see also section IV G of the Instructions for Use).

In the case of the models "e etc." the 20-db attenuator is no longer switched with key T1, but with switch S7. On these models the range switch S3 encompasses +20 db to -70 db. The ranges of -80, -90, and -100 db are additionally set with switch S7 "0, -10, -20, -30 db". This secures that the most favorable S/N ratio as well as lowest residual distortion can be brought about in all measuring ranges.

The final amplifier following the filters consists of two amplifier stages with individual degeneration, using each one tube CCa in an R-C arrangement. With the calibrating control in the degenerative path the gain of the first stage can be varied by approx. 6 db. Its total gain is about 52 db, its maximum output approx. 4 v RMS.

For rectification the detector circuit contains two germanium diodes in a voltage doubler circuit. The charging and discharging time constants are selected so that the AC voltage is measured in RMS values (which is of importance with noise level measurements, among other applications).

The amplifier output voltage (f_{z4} = 3 kc/s) is available at the jack " ~ ". When this output is used, the detector circuit is disconnected by a plug-actuated contact. At the jack " - " it is possible to take a DC voltage for feeding a current or voltage recorder as well as a scale expansion device Type Rel 3 B 942 (see section C4, page 28).

C. Attachments

1. Probe Type Rel 3 B 938

High-impedance measurements directly at the measuring points within a device or a bay can be made with the probe Type Rel 3 B 938. It consists essentially of a cathode follower. Its input impedance is approx. 1.6 meg shunted by 10 pf. The output impedance is matched to Z = 75 Ω, the insertion loss introduced by this being approx. 20 db (2 N). For calibration the calibrating voltage of the level meter Type Rel 3 D 335 is applied to the probe from the jack "Probe Checking". This secures that the accu-

racy of the level meter is fully maintained even in operation with the probe. The probe is supplied with power from the level meter via the connecting jack provided for this purpose.

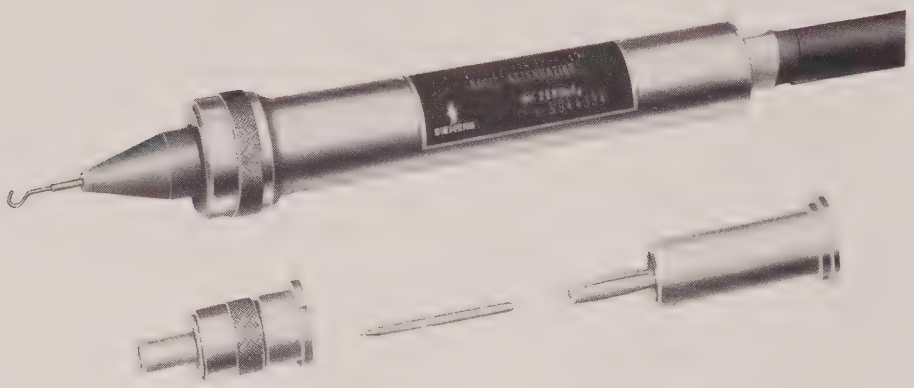


Fig. 13 High-impedance probe with different prods

Tentative Electrical Data:

	Type Rel 3 B 938	
	a2a (db) a3a (dbm)	a1a (N) a4a (Nm)
Frequency range	10 kc/s to 17 mc/s	
Insertion loss	approx. 20 db	2 N
Frequency response of the insertion loss as referred to 1 mc/s	±0.15 db	±0.015 N
With changes of the mains voltage of ±10 %, the insertion loss varies by	±0.2 db	±0.02 N
Input impedance	approx. 1.6 meg shunted by ≈10 pf	
Output impedance	75 Ω	

	Type Rel 3 B 938	
	a2a (db) a3a (dbm)	a1a (N) a4a (Nm)
Measuring ranges for the zero mark on the instrument of the level meter Type Rel 3 D 335, can be switched in steps of 10 db/1 N . . .	-80 to -10 db	-9 to -1 N
for Z = 50 to 75 Ω	-70 to ±0 dbm	-8 to ±0 Nm
for Z = 125 to 150 Ω . . .	-70 to -5 dbm	-8 to -0.5 Nm
Minimum measurable level	-90 db/-80 dbm	-10 N/-9 Nm
Minimum readable level	-105 db/-95 dbm	-12 N/-11 Nm

2. Coaxial-Insertion Coupling Type Rel 3 B 940

When automatic tuning is used, there are several outer conductors (with chassis potential) between oscillator and detector that necessarily have different electrical characteristics. The current I1 (see the equivalent circuit in Fig. 14) flowing through the input of the specimen under test, will therefore be distributed to the outer conductors in dependence on the coupling resistances, e.g. R_{k1} to R_{k3}. The current I_1" will then bring about an interfering voltage E_{st} in the lead connecting the specimen to

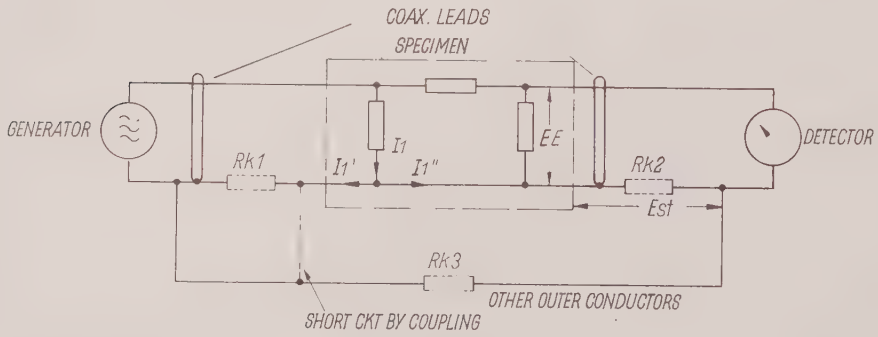


Fig. 14 Equivalent circuit for the coaxial-insertion coupling

the level meter. When high attenuation values are measured, this voltage is no longer negligible with respect to the voltage under test. By running all connecting cords via the coaxial-insertion coupling the short-circuit shown in Fig. 14 can be established which prevents the interfering current I_1" from reaching the detector circuit. This short-circuit is the

more effective, the closer the coaxial-insertion coupling is located to the specimen, i.e. the shorter the connecting cord between insertion coupling and specimen is with respect to the other cords.

3. Reflection Coefficient Bridge Type Rel 3 R 132 (5) 10 kc/s to 15 (30) mc/s

Development and testing of communications equipment often require close investigations of the reflection as a function of frequency. With the reflection coefficient bridge Type Rel 3 R 132 the carrier-frequency measuring setup can be simply and rapidly expanded for these measurements. The measuring bridge in a Wheatstone configuration features a

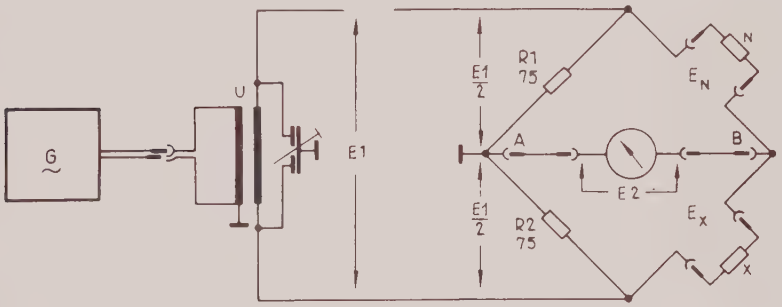


Fig. 15 Basis circuit diagram of the reflection-coefficient bridge

particularly low residual reflection and high measuring accuracy. Owing to its compactness, it can readily be integrated in any desired measuring setup. The basic layout of the measuring bridge with the fixed arms R1 and R2 contains the reflection coefficient bridge (Type Rel 3 R 132) with the plugged-in external impedance standard Z = 75 Ω (Type Rel 3 B 3121), and the specimen under test X or external reflection standard r = 0.05 (Type Rel 3 B 3122).

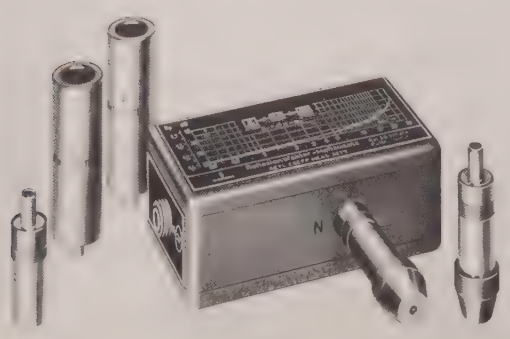


Fig. 16 Reflection-coefficient bridge with impedance standards and adapters

The unbalanced measuring voltage is applied via a high-grade transformer to one of the bridge arms so that the voltage (E_1) is halved via the two resistors R1 and R2.

If X and N are unequal, an unbalance voltage E_2 results between point A and point B. It is applied to a level meter.

There are the following relations between N and X, and E_1 and E_2:

$$E_2 = \frac{E_1}{2} - E_x \qquad E_x = E_1 \times \frac{X}{X + N}$$

Hence: $$E_2 = \frac{E_1}{2} \times \frac{X - N}{X + N}$$

From the definition of the reflection coefficient

$$r = \frac{X - N}{X + N}$$ follows: $$r = \frac{2\,E_2}{E_1}$$, i.e. the ratio $\frac{E_2}{E_1}$

equals half the reflection coefficient of the specimen as referred to the standard N. The voltage E_2 varies in proportion with the bridge unbalance and hence also in proportion with the reflection coefficient r.

The signal-to reflection ratio in decibel can be calculated from:

$$a_r = 20 \log_{10} \frac{1}{r} = 20 \log_{10} \frac{X + N}{X - N}$$

The insertion loss a_o of the reflection coefficient attachment depends upon the measuring setup. Measuring charts supplied with the equipment show the various measuring setups with the associated insertion loss a_o and the related frequency-dependent attenuation $\triangle$ a in the form of a curve versus frequency.

The bridge and the impedance standard, both of which are precision assemblies, are supplied in a box which also contains two adapters 2.5/6 to 4/13 and a reflection standard r = 0.05, which serves for checking the accuracy of the respective measuring setup.

For the connection of the specimen a coaxial connector 2.5/6 has been included.

Electrical Data:

Frequency range:

When the generator output and detector input impedances are 75 Ω . . . . . 100 kc/s to 30 mc/s

When the source impedance of the generator is about 0 Ω and the detector input impedance "high" with respect to 75 Ω . . . . . (5) 10 kc/s to 5 mc/s

Measuring range for reflection coefficients:

From the lower limit determined by the measuring accuracy . . . . . up to r = 1

Measuring error $\triangle$ r introduced by the fixed bridge arms

up to f = 5 mc/s . . . . . $\pm$0.002

up to f = 15 mc/s . . . . . $\pm$0.005

up to f = 30 mc/s . . . . . $\pm$0.01

Reflection coefficients of the impedance standard Z = 75 Ω

up to f = 15 mc/s . . . . . r $\leq$ 0.003

up to f = 30 mc/s . . . . . r $\leq$ 0.005

of the reflection standard r = 0.05

up to f = 15 mc/s . . . . . r = 0.05 $\pm$0.003

up to f = 30 mc/s . . . . . r = 0.05 $\pm$0.005

Insertion Loss of the Measuring circuit up to f = 300 kc/s

With a generator output and detector input impedance of 75 Ω . . . . . 12.1 db

With a generator source impedance of approx. 0 Ω and when the detector input impedance is high with respect to 75 Ω . . . . . 6.1 db

Maximum permissible input level at the bridge . . . . . +15 db

Input and output impedance of the bridge at N = X = 75 Ω . . . . . 75 Ω

4. Scale Expansion Device Type Rel 3 B 942

This attachment has an instrument scale of ±1 db, which permits lowest level increments down to 0.02 db to be read off. This is, for instance, of special importance in the testing of the pass band of a filter. Pass band distortion, hardly detectable on usual level meter scales, can be rapidly and reliably measured without difficulty. The scale expansion device provides distinct advantages in serial tests of quadripoles (amplifiers or attenuators) by means of the comparison method.

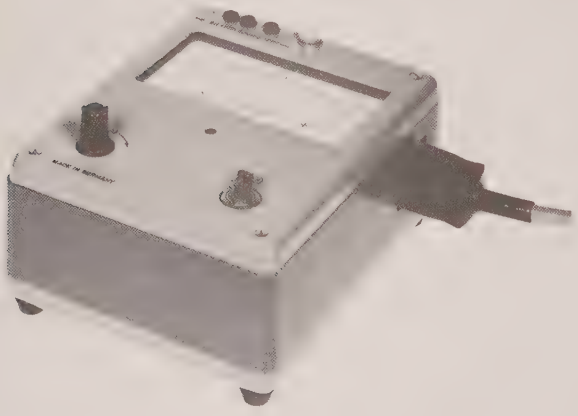


Fig. 17 Scale expansion device Type Rel 3 B 942

Basically, the device can be used for all level meters that are equipped with a 100-µa indicating instrument. It is independent of the frequency range of the level meter since the measuring voltage is derived from the DC end of the measuring circuit (jacks "-" on the level meter Type Rel 3 D 335).

Tentative Electrical Data

Measuring range △ p	±1 db/±0.1 N
Current required for p = 0 db/0 N	77.5 µa ±1 µa
Minimum measurable level increment	0.02 db (0.002 N)
Measuring error as referred to the △ p-reading	approx. 3 %
With mains voltage variations of ±10 %, the indication varies by	≦ 0.015 db (0.0015 N)
Power supply	110, 130, 220, 240 v ±10 %, approx. 5 va

5. Regulating Amplifier for Constant Level Oscillator Voltage Type Rel 3 B 944

Details available upon request.

D. Expansion to a Sweep-Frequency Measuring Setup

A further considerable saving of time, as demanded e.g. in the measurement of large lots of uniform subassemblies and devices, can be realized by the use of sweep-frequency equipment. From production series c onward, the level oscillators are so designed that the simple connection of the sweep-frequency attachment Type Rel 3 W 933 makes the level oscillator a fully-electronic sweep-frequency oscillator.

The sweep-frequency attachment Type Rel 3 W 933 has a center frequency that is continuously adjustable throughout the frequency range. The sweep range can be stepwise varied in several ranges. Intermediate values can be finely set. When the center frequency is varied, the sweep range remains constant and conversely, when the sweep range is varied, the center frequency remains constant.

By replacing the generator slide-in chassis for wide sweep ranges ($\pm$8 kc/s to $\pm$7.5 mc/s) by the one for narrow sweep ranges ($\pm$500 c/s to $\pm$10 kc/s) and variation of the sweep frequency within wide limits (between 0.01 and 25 c/s) a good adaptation is possible to the multitude of measuring problems encountered in practice, for this setup allows narrow-band specimens with large changes in the envelope delay to be measured as simply as wideband specimens with a flat frequency response.

A special asset is that the symmetry of the sweep action permits the measuring curve to be traced out in the forward and return sweep, so that lack of coincidence at once reveals that the sweep frequency is excessive for the specimen. In addition, it is possible to "stop" the sweep and vary the frequency by hand.

The sweep system furnishes frequency markers that serve for distinct identification in nearly all cases occurring in practice. The frequency markers have the full accuracy of the level oscillator Type Rel 3 W 518, since in swept operation the generator unit G1 or G2 in the level oscillator assumes

the function of the marker generator. Further frequency markers or even a frequency spectrum can be generated by applying suitable voltages to the sweep-frequency attachment.

A regulating system automatically offsets the frequency response of the set nominal level. For this purpose a DC voltage is taken from the detector circuit of the level oscillator for application to the regulating amplifier in the sweep-frequency attachment. With the measuring probe Type Rel 3 B 939 this reference voltage can also be taken directly at the input of the specimen, however. This compensates for frequency response due to the external circuit, e.g. unavoidable mismatch. In this case the maximum level deviation is ± 1 %, even with the widest sweep.

The receiving-end equipment of this sweep-frequency measuring setup consists of the selective level meter Type Rel 3 D 335, when the considerable advantages of selective measurements are to be utilized, or of a wideband level meter. For the indication the novel level tracer Type Rel 3 D 346 is suitable, which features a large screen area and a grid of coordinates that is freely selectable within wide limits and is traced out without parallax by the electron beam itself.

Depending upon the amplifier slide-in chassis, its frequency range extends from 30 c/s to 16 mc/s. Owing to the long persistence of the employed cathode ray tube, a continuous trace appears on the screen even with very slow sweeps.

With certain qualifications, it is basically possible to replace the level tracer by any other standard oscilloscope, provided that it has external terminals for the X-deflection plates or a DC amplifier in the X-deflecting section.

E. Expansion to a Pilot Level Measuring Setup

Routine checking and supervision measurements on multichannel carrier systems (such as the system V960) can be made during operation if at the transmitting end a number of pilots, whose frequencies fall on the gaps between the supergroups, are sent to line simultaneously with the communications signals.

At the extraction points of the system these measuring pilots can be selectively measured along the link. Their levels show the frequency-dependent response at the place of measurement, which gives the information for necessary corrective action or for detecting trouble in time.

The selective level meter Type Rel 3 D 335 is well suited for this application because of its netting accuracy, its frequency stability, and its sensitivity.

At the transmitting end the pilot level oscillator Type Rel 3 W 65 is available as a suitable generator. By means of pushbuttons up to 16 measuring pilots can be activated for application to the carrier system, either singly or together. The frequencies of the measuring pilots are those recommended by the CCI. Their error is as low as $\leq 1.5 \times 10^{-5}$. The CCI recommendations as to level stability are also complied with.

F. Connection of Recording Equipment

Graphic recording equipment can be connected to the output "-" of the level meter. Both high-impedance and low-impedance recorders can be used. In either case the instrument of the level meter remains in operation and the measuring accuracy as well as the RMS response are maintained if the calibration is repeated after connection of the recorders and some considerations are observed (see the Section IV J of the Instructions for Use, page 12).

IV. ACCESSORIES, DIMENSIONS, AND WEIGHTS

Description		Type	Dimensions in ft./in (mm)	Approx. weight in lb (kgs)
Level oscillator				
(10 kc/s to 17 mc/s)				
-8 to +1 N	cabinet model . . .	Rel 3 W 518d 1a (e1a)	1'9 7/8" x 1'3 1/2" x 1' 1/8" (556 x 394 x 307)	66 (30)
	rack-mounting model	Rel 3 W 518d 1b (e1b)	1'8 1/2" x 1'1 3/8" x 8 7/8" (520 x 338 x 225)	61.6 (28)
-75 to +10 db	cabinet model . . .	Rel 3 W 518d 2a (e2a)	1'9 7/8" x 1'3 1/2" x 1' 1/8" (556 x 394 x 307)	66 (30)
	rack-mounting model	Rel 3 W 518d 2b (e2b)	1'8 1/2" x 1'1 3/8" x 8 7/8" (520 x 338 x 225)	61.6 (28)
-75 to +10 dbm	cabinet model . . .	Rel 3 W 518d 3a (e3a)	1'9 7/8" x 1'3 1/2" x 1' 1/8" (556 x 394 x 307)	66 (30)
	rack-mounting model	Rel 3 W 518d 3b (e3b)	1'8 1/2" x 1'1 3/8" x 8 7/8" (520 x 338 x 225)	61.6 (28)
-8 to +1 Nm	cabinet model . . .	Rel 3 W 518d 4a (e4a)	1'9 7/8" x 1,3 1/2" x 1' 1/8" (556 x 394 x 307)	66 (30)
	rack-mounting model	Rel 3 W 518d 4b (e4b)	1'8 1/2" x 1'1 3/8" x 8 7/8" (520 x 338 x 225) 338 225	61.6 (28)
Accessories				
20 tubes		CCa	-	-
1 tube		E91AA	-	-
2 stabilizer tubes		108 C 1	-	-
3 fuses G (2 as spares)				
0.6 amp for 220/240 v		0,6 AD DIN 41576	-	-
1.2 amp for 110/130 v		1,2 AD DIN 41576	-	-
4 indicating lamps 6 v		Fg lp 62c	-	-
2 coaxial U-links		Rel stv 13 m	-	-
Optional				
1 coaxial connecting cord				
4/13 mm for Z = 75 Ω		Rel 657 A 119c 2,4, 5	1'8"; 3'3"; 5' (500; 1000; 1500)	0.44 (0.2)
or for Z = 60 Ω		Rel 657 A 120b 2,4, 5	1'8"; 3'3"; 5' (500; 1000; 1500)	0.44 (0.2)
1 adapter 4/13 mm to 2.5/6 mm . .		Rel stv 113	3" x 7/8" dia. (76 x 22 dia.)	0.44 (0.2)
1 balancing transformer		Rel 3 B 216	2" x 43/4" x 1 3/4" (50 x 120 x 45)	0.44 (0.2)
1 coaxial-insertion coupling . .		Rel 3 B 940	2 3/8" x 3 1/2" x 3/4" (60 x 90 x 20)	0.66 (0.3)
1+ coaxial connecting cord				
for Z = 75 Ω		Rel 657 A 119c1	1' (300)	0.44 (0.2)
for Z = 60 Ω		Rel 657 A 120c1	1' (300)	0.44 (0.2)
For the automatic tuning systems f_1 and f_2:				
2 (4+) coaxial connecting cords		Rel 657 A 119c 2 to 4	1'8" to 3'3" (500 to 1000)	0.44 (0.2)

+ when a coaxial insertion coupling is used

Description	Type	Dimensions in ft./in (mm)	Approx. weight in lb (kgs)
For modulation:			
1 level oscillator e.g. 10 c/s to 1 mc/s	Rel 3 W 38	1'9 7/8" x 1'3 1/2" x 11 7/8" (558 x 392 x 300)	63.8 (29)
1 connecting cord e.g.	Rel ltg 546 a to d	1'8" to 6'7" (500 to 2000)	0.44 (0.2)
For swept operation:			
1 sweep-frequency attachment with accessories	Rel 3 W 933	1'9 7/8" x 10 1/8" x 1'4 1/4" (558 x 256 x 410)	44 (20)
Selective Level Meter			
(10 kc/s to 17 mc/s)			
-12 to -2 N cabinet model . . .	Rel 3 D 335d 1a	1'9 7/8" x 1'3 1/2" x 1' 1/8" (556 x 394 x 307)	68.2 (31)
rack-mounting model	Rel 3 D 335d 1b	1'8 1/2" x 1'1 3/8" x 8 7/8" (520 x 338 x 225)	63.8 (29)
-110 to +20 db cabinet model . . .	Rel 3 D 335d 2a	1'9 7/8" x 1'3 1/2" x 1' 1/8" (556 x 394 x 307)	68.2 (31)
rack-mounting model	Rel 3 D 335d 2b	1'8 1/2" x 1'1 3/8" x 8 7/8" (520 x 338 x 225)	63.8 (29)
-100 to +30 dbm cabinet model. . .	Rel 3 D 335d 3a	1'9 7/8" x 1'3 1/2" x 1' 1/8" (556 x 394 x 307)	68.2 (31)
rack-mounting model	Rel 3 D 335d 3b	1'8 1/2" x 1'1 3/8" x 8 7/8" (520 x 338 x 225)	63.8 (28)
-11 to +3 Nm cabinet model . . .	Rel 3 D 335d 4a	1'9 7/8" x 1'3 1/2" x 1' 1/8" (556 x 394 x 307)	68.2 (31)
rack-mounting model	Rel 3 D 335d 4b	1'8 1/2" x 1'1 3/8" x 8 7/8" (520 x 338 x 225)	63.8 (29)
Accessories			
21 tubes	CCa	-	-
1 tube	E91AA	-	-
1 stabilizer tube	108 C 1	-	-
3 fuses G (2 as spares)			
0.6 amp for 220/240 v	0,6 AD DIN 41576	-	-
1.2 amp for 110/130 v	1,2 AD DIN 41576	-	-
5 indicating lamps 6 v	Fg lp 62 c	-	-
Optional			
1 coaxial connecting cord			
4/13 mm for Z = 75 Ω	Rel 657 A 119c		
	2,4, 5	1'8", 3'3", 5' (500, 1000, 1500)	0.44 (0.2)
for Z = 60 Ω	Rel 657 A 120b		
	2,4, 5	1'8", 3'3", 5' (500, 1000, 1500)	0.44 (0.2)
1 adapter, e.g.			
2.5/6 mm to 4/13 mm	Rel stv 113	3" x 7/8" dia. (76 x 22 dia.)	0.66 (0.3)

Description	Type	Dimensions in ft./in (mm)	Approx. weight in lb (kgs)
1 probe	Rel 3 B 938	5 1/2" x 3/4" dia. (140 x 20 dia.)	0.66 (0.3)
1 balancing transformer	Rel 3 B 216	2 1/2" x 2 5/8" x 5 1/8" (62 x 65 x 130)	0.44 (0.2)
1 reflection-coefficient bridge	Rel 3 R 132	2 3/8" x 4 3/8" x 1 3/4" (60 x 110 x 45)	1.1 (0.5)
in addition:			
2 coaxial connecting cords 2.5/6 to 4/13	Rel ltg 598a to c	1' to 2'5" (300 to 750)	0.44 (0.2)
1 scale expansion device	Rel 3 B 942	6 1/4" x 4 7/8" x 2 3/4" (158 x 125 x 70)	3.3 (1.5)
1 regulating amplifier	Rel 3 B 944	upon request	
Terminations			
75, 65 Ω	Rel 3 B 333a,k	4" x 3/4" dia. each (102 x 18 dia. each)	0.22 (0.1) each
For swept operation:			
1 level tracer	Rel 3 D 346	1'10" x 1'3 1/2" x 1'8 1/8" (558 x 392 x 510)	79.2 (36)

I N S T R U C T I O N S F O R U S E

Attention: Use the equipment in vertical position only.

I. PREPARATION

The equipment leaves the factory with the adjustment for connection to 220-v mains. For operation on other AC mains, the chassis must be withdrawn from the casing and the voltage selector S6 (at the upper part of the power supply subassembly near the power transformer) must be set for the desired mains voltage. If only a mains voltage of 230 v is available, the devices can be adjusted by resoldering a link on the power transformer:

On the level oscillator the link 10d - 9d on the transformer must be removed and replaced by a link between 9d - 8d.

On the level meter the link 1b - 2b on the transformer must be removed and replaced by a link between 2b - 3b.

For operation with a mains voltage of 230 v, the voltage selector S6 must be set at 240 v in both level oscillator and level meter.

In the case of operation from 110 v or 130 v AC mains, the 0.6-amp fuse must be replaced by a 1.2-amp unit.

In accordance with the safety regulations of the Association of German Electrical Engineers (Verein Deutscher Elektrotechniker; VDE), mains-operated equipment whose touch potential may exceed 65 v with respect to ground in the case of a fault, must have a protective terminal. For this reason the devices are provided with a power cord with protective terminal and three-wire safety plug (Schuko plug) for connection to an outlet with protective ground terminal (Schuko outlet). Correspondingly, the rack-mounting models are permanently connected to the three-pole electrolier-type terminal block beside the power switch. The plug connection and the cross section of the non-current carrying protective lead must be equivalent to those of the current carrying leads.

When the three-wire safety plug must be exchanged for another (locally used) plug with protective terminal, the three wires (red, grey, and black) of the power cord must be connected as follows:

In the case of non-polarized plug systems:
Red lead to the protective terminal,
grey and black leads to the current-carrying terminals.

In the case of polarized plug systems in mains with phase and neutral:
Red lead to the protective terminal,
grey lead to the neutral terminal,
black lead to the "phase" terminal.

If the power mains has no protective terminal, a ground connection free of interfering potentials must be established prior to placing the device into operation, e.g. to the terminals provided for this purpose (" ⏚ " on the front panel). When the Schuko plug is exchanged for a locally used two-prong plug, do not connect the red wire of the power cord, but insulate it, and connect the grey and black wires to the current-carrying terminals.

Under no circumstances must ground leads be interrupted as the setup is being established or modified, as long as power is applied to the equipment.

II. LAYOUT OF THE MEASURING SETUP

The ventilation system of the equipment and the instruments are designed for arrangement of the equipment with vertical front panel. The top face of the casings must remain free, but stacking upon other devices, e.g. of the level oscillator onto the sweep-frequency attachment, is permissible.

The annexed figures 2 ff. show typical measuring setups for various measuring applications. To avoid measuring errors, the connecting cords mentioned in each case should be used, if possible, especially when coaxial or double-shielded lines are involved (Types Rel 657 A 119 ..., B 120 ...; see also Section IV of the Description: Accessories, Dimensions, and Weights).

Irrespective of the impedance of the specimen, interconnect the jacks "Synchr. f_1 and f_2" always with cords Z = 75 Ω, Type Rel 657 A 119 ...

The jacks "Sweep Gen A to F" on the level oscillator serve for the connection of the sweep-frequency attachment Type Rel 3 W 933. In operation without sweep-frequency attachment, the coaxial U-links "Sweep Gen A → B" and "Sweep Gen C → D" must always be in position, since when these connections are withdrawn, the oscillator units G_1 and/or G_2 are shut down.

If high attenuation values, e.g. the stop-band losses of filters, are to be measured, it is advisable to interpose the coaxial-insertion coupling Type Rel 3 B 940 mentioned in Section III C 2 of the Description (annexed Fig. 2b). Take special care that the connection between the coaxial-insertion coupling and the input of the specimen is short, and that the total length of the connection coupling/specimen/level meter is shorter than the connection between the coupling and the level oscillator.

Energize the devices, the scale lamps light up. The position of the controls and the connecting facilities, their lettering, and symbols are shown in the panel views (annexed Fig. 1).

III. CALIBRATING AND SETTING

A. Frequency Calibration of the Level Oscillator

Do not change the position of the control "Corr.f_1". (This is only necessary in compensating for aging effects. See the "Notes on Maintenance").

Operate switch S4 to the position "Tuning In Spectrum Steps n x 100 kc/s".

Operate the control "Tuning f_1" (megacycle scale) to 0 mc/s. The green lamp "Lock-in" must light up.

Set the control "Fine Tuning f_2" (kilocycle scale) exactly to 0 kc/s. The lamp"f_2Indicator" must not go out (do not make any adjustments on the potentiometer R2 beside the indicator lamp, for it serves only to compensate for aging phenomena; see Notes on Maintenance, p.4, sect. II C).

Adjust zero beat with the control "Corr.f_2". During this operation, the indication of the instrument moves slowly to $-\infty$. To obtain an exact alignment it is recommended to find the average of two equal pointer deflections for the trimmer position "Corr.f_2". Zero beat can additionally be monitored with earphones. When very exact measurements are desired, this calibration must be repeatedly checked until the device has reached thermal equilibrium (after about two hours of operation).

> The device is now calibrated in frequency. No readjustment of the frequency scale f_1/mc/s is necessary, since it is derived from the 100-kc/s crystal generator.

B. Setting the Frequency of the Level Oscillator

With switch S4 there can be selected either the position "Continuous Tuning" or "Tuning In Spectrum Steps n x 100 kc/s" (for high requirements as to frequency stability and accuracy).

When switch S4 is at "Tuning Continuous", any desired frequency of the entire frequency range can be set with the control "Tuning f_1" alone. In addition, a fine control of intermediate values up to 100 kc/s is possible with the control "Tuning f_2".

When switch S4 is at "Tuning In Spectrum Steps n x 100 kc/s", the next lower 100-kc/s line of the desired measuring frequency can be so set that the green lamp "Lock-in" lights up. Adjust the remaining difference with the control "Tuning f_2". The lamp "f_2 Indicator" must not go out.

C. Source Impedance of the Level Oscillator

Match the source impedance of the oscillator to the customary Z-values of the specimen under test with switch S3 "Z/Ω". A further position is Z/~ 0 Ω (green lettering). It allows non-incorporated Z-values to be supplemented by external build-out.

D. Setting the Oscillator Level

With switch S2, the voltage levels between -60 and +10 db (green lettering) for $Z_i \sim 0$ Ω (green lettering), and between -70 and 0 db (black lettering) for $Z_i = Z$ can be set in steps of 10 db. Set intermediate values with the fine control P1 according to the instrument scale.

By depression of button T1 "Disabling" the oscillator voltage is disconnected. This permits the measuring level to be provided with an indication signal, for instance, (by repeated short interruptions) to achieve greater security in identifying it at the receiving end from among the other signals.

E. External Modulation of the Level Oscillator

Amplitude modulation is possible by connecting an external voltage source with the frequency 0 to 100 kc/s to the input "Mod. Ext.". For 100% modulation the necessary modulating voltage is approx. 4 v.

F. Calibrating the Tuning Frequency of the Level Meter
Do not change the position of the control "Corr. f_1".
(his is only necessary in compensating for aging effects. See the "Notes on Maintenance").

Operate the function switch S4 to the position "Tuning In Spectrum Steps n x 100 kc/s, Pass Band Width 200 c/s".

Operate the level switch S3 to " ▼ ".

Bring the control "Tuning f_1" (megacycle scale) to 100 kc/s (within the range of the calibrating mark " ▼ "). The green lamp "Lock-in" must light up.

Operate the control "Fine Tuning f_2" (kilocycle scale) exactly to the 0-kc/s line (calibrating mark " ▼ ").

During this procedure the lamp "f_2 Indicator" must not go out (do not make any adjustments on the potentiometer R2 (beside the indicator lamp), for it serves only to compensate for aging phenomena, see Notes on Maintenance, p.4, sect. II C).

Set the control "Corr.f_2" for maximum indication on the instrument. The device is now calibrated in frequency. No readjustment of the f_1/mc/s frequency scale is necessary, since it is derived from the 100-kc/s crystal generator.

G. Calibrating the Indication of the Level Meter

The luminous turnkey T1 "Reading -20 db" must not be depressed (must be dark). With model e, switch S7 "Reading 0 to 30 db" must be in position "0", or else no calibration is possible. During the calibrating procedure open the sync connection f1 to the level oscillator.

The level switch S3, the function switch S4, the tuning controls f_1 and f_2 must be in the positions described under F. The lamps "Lock-in" and "f_2 Indicator" must light.

By slightly varying the position of the fine tuning control f_2 within the range of the calibrating mark make an exact setting to the calibrating frequency (100 kc/s)(maximum deflection on the instrument). With the rotary control P ("Cal. ▼ ") adjust the pointer deflection exactly to the red calibrating mark " ▼ " on the instrument.

When the measurements are to be very exact, it is recommended to repeatedly check the calibrations during the first two hours after energization until the device has reached its thermal equilibrium.

IV. MEASURING

A. Input Impedance and Termination of the Specimen

With switch S2 "Z/Ω" the input impedance of the level meter can be matched to customary Z-values of the specimen. This switch has a further position Z/ $\sim \infty$ Ω.

It is advisable to terminate the specimen into the level meter, i.e. if possible, the suitable incorporated termination shall be used or a termination plugged into the second parallel-connected input jack. This widely eliminates the influence of the leads. When a termination is plugged, switch S2 must be operated to " ∞ ".

With measurements on a carrier transmission system that is terminated for normal operation, the Z-switch must always be operated to " ∞ ". Also in this case it is advisable in the case of longer leads, and absolutely necessary at frequencies beyond 1.5 mc/s, to split the circuit at the measuring point and terminate that part of the system which forms the termination for the measurement into the parallel jack of the level meter input.

When "built-in" coupling circuits (measuring hybrids) are used, the specified Z-values must be adjusted prior to connecting the level meter.

B. Tuning an Measuring

Set the range switch S3 so that the expected receiving level can be read off in the upper third of the instrument scale, if possible. Use a middle range when an unknown receiving level is involved.

Note that in all measurements where full sensitivity is not required, key T1 should, as a matter of principle, be not depressed in accordance with section D (in the case of the models e ...), while switch S7 is to be operated to the position "0 db" (except for measurements of signal-to-distortion ratios, see section G).

First set switch S4 to the position "Tuning Continuous" (pass band width 2 kc/s). Slowly rotate the tuning control f_1 until the meter shows a deflection.

Set the frequency for maximum indication, if necessary with the aid of the tuning control f_2. When need arises, change the position of switch S3 so that the maximum indication appears in the upper third of the scale.

If the measuring frequency is to be exactly determined or if high tuning stability is required (e.g. in continuous supervision) switch for "Tuning In Spectrum Steps". For this purpose, operate the function switch S4 "Tuning In Spectrum Steps n x 100 kc/s, Pass Band Width 200 c/s or 2 kc/s". Set the tuning control f_1 to the next lower 100-kc/s line of the measuring frequency so that the green lamp "Lock-in" lights up. Subsequently readjust the tuning control f_2 for maximum instrument indication. The measuring frequency is the sum of the settings f_1 and f_2. The AC output voltage (3 kc/s) proportional to the indication is available at the jacks "$\sim$". When, for instance, an earphone or oscilloscope is plugged, the instrument is disconnected by insertion of the plug. At the jacks "-" the rectified voltage is available for connection of a graphic current or voltage recorder. In this case the instrument is not disconnected by insertion of the plug. See also section F of the "Description" (page 31).

C. Pass Band Width

With switch S4, the level meter can be set to a pass band width of either 2 kc/s or 200 c/s. In the position"2 kc/s" the pass band, for an increase in attenuation of 3 db, corresponds approximately to the width of a voice channel of 3.1 kc/s.

To separate closely spaced frequencies and suppress interfering voltages when the full sensitivity is utilized, it is advisable to make the measurement in the position "Pass Band Width 200 c/s".

When the full sensitivity is to be utilized at frequencies below 30 kc/s, the measurement must be made with the pass band width of 200 c/s. With the pass band width of 2 kc/s and at frequencies below 30 kc/s, the key T1 ("Reading -20 db") or in the case of the models e . . the positions -10 to -30 db of switch S7 shall not be used (see also the following section D).

D. Signal-to-Noise Ratio

Special appliacations, e.g. the presentation of curves on the screen of a tracer or the increase in the relative measuring accuracy by "scale expansion" with the aid of the scale expansion device Type Rel 3 B 942 require an S/N ratio as high as possible. The ratio is best when the key T1 ("-20 db") is not actuated or (in the case of the models e ...) when switch S7 is at 0 db. In order to avoid measuring errors as largely as possible, its activated condition is indicated by a lamp. As a matter of principle, the key or the switch S7 shall only be operated when an increased sensitivity of the device is absolutely required.

E. Use of a Probe

The terminals "Probe" and "Test Probe" are provided for operation with the probe Type Rel 3 B 938.

F. Measurements with Synchronization

The automatic tuning system permits selective measurements to be carried out as rapidly and simply as wideband measurements. The frequency has to be set on the level oscillator only, no tuning being necessary on the level meter.

The main and the fine tuning systems (f_1 and f_2) can be run in synchronous operation simultaneously or separately, as desired, with continuous tuning as well as with tuning in spectrum steps.

For this purpose only the corresponding connections "Synchr." (level oscillator) to "Synchr." (level meter) must be established. To avoid measuring errors, the double-shielded cords Type Rel 657 A 119 ($Z = 75\ \Omega$) should be exclusively used for these connections. When very high attenuation values are measured, the coaxial-insertion coupling Type Rel 3 B 940 must also be used (see section II and annexed Fig. 2b).

Synchronization of f_1

When the jacks "Synchr. f_1" of the level oscillator and the level meter are used, the oscillator unit f_1 of the level meter is disconnected and replaced by oscillator unit f_1 in the level oscillator. The interpolation

oscillator unit f_2 in the level meter works as in measurements without synchronization, i.e. the level meter must be aligned for maximum indication with the control "Fine Tuning f_2" prior to beginning the measurements. For any further frequency f_1 adjusted on the level oscillator, the level meter is automatically tuned by the level oscillator.

Synchronization of f_2

When the connecting cord "Synchr. f_2" is plugged, the auxiliary oscillator unit G_2' (300 to 200 kc/s) of the level meter is replaced by that of the level oscillator. In this setting the lamp "f_2-Indicator" must not go out, or else R2 must be readjusted so that the lamp lights up again. (Caution. Do not use the end positions). Minor frequency differences of the other auxiliary oscillators of the two sets can be compensated for, especially when the measurement is to be made with the level meter in the position "Pass Band Width 200 c/s" (in the case of "Pass Band Width 2 kc/s" no correction is necessary in most cases).

Compensating for these frequency differences:
Effect the first measurement without "Synchr. f_2", then connect the jacks "Synchr. f_2" of the level oscillator to those of the level meter.

Operate the function switch S4 of the level meter to the position "Pass Band Width 200 c/s". Readjust the control "Corr. f_2" for maximum indication on the level meter. Here the same pointer deflection as without synchronization must be achieved. If such is not the case, the indication must additionally be maximized with the controll "Corr. f_2" on the level oscillator.

For any further frequency set with the control "Fine Adjustment f_2" the level meter will be automatically tuned by the oscillator.

Synchronization of f_1 and f_2

If the measuring setup is to be operated with full synchronization, the correct adjustment of the trimmer "Corr. f_2" for maximum instrument indication must be checked first (after the two synchronization cords have been plugged). The further frequency settings f_1 and f_2 will then be controlled by the level oscillator.
It is advisable to repeatedly check the adjustment of the trimmer "Corr. f_2" during the first two hours after energization of the devices, until thermal equilibrium is reached.

G. Measuring High Signal-to-Distortion Ratios

A general prerequisite in the measurement of signal-to-distortion ratios is sufficiently low residual distortion of the level meter with respect to the distortion to be measured. This prerequisite is fulfilled when the level of the fundamental frequency at the input amplifier and at modulator 1 is as low as possible. For this reason the following information must be considered when signal-to-distortion ratios of $\geq$ 45 db (5 N) are to be measured with a measuring accuracy as high as possible:

1. As a matter of principle, the luminous turnkey "Reading -20 db/-2 N" (switch S7 in the case of model "e") must be switched to -20 db/-2 N (-30 db/-3 N).

2. (Only necessary in the case of the models "d"). Select the level or the position of the function switch S3 so that the value indicated for this level of the fundamental frequency on the instrument scale is not above the -10-db (-1-N) mark.

   Thus the residual distortion of the level meter is $\geq$ 70 db (8 N) down as referred to the useful signal. The most favorable position of the calibrating control is the CW stop.

3. A further increase in the signal-to-residual-distortion ratio to about 80 db (9 N) can be achieved

a. in the case of the models "d":
   by setting the level of the fundamental frequency (e.g. by interposing an attenuator pad) so that with the calibrating control fully opened and switch S3 in position -20 db(-10 dbm/-3 N/-2 Nm) the indication of the level of the fundamental frequency is below the -10 db (-1 N) mark,

b. in the case of the models "e":
   if the indication of the level of the fundamental frequency is below the -10 db (-1 N) mark.

H. Measuring Narrow Filters With Steep Attenuation-vs.-Frequency Characteristic

In such measurements complete absence of interference in the measuring setup is required. For this reason it is absolutely necessary that double-shielded connecting cords be used and that, when automatic tuning of the level meter is effected from the oscillator, the coaxial-insertion coupling be employed. Be particularly careful in carrying out the tuning correction f_2.

Caution: With the level oscillators Type Rel 3 W 518d ... with a serial number up to 5/754387 incidental phase modulation (with a phase excursion of approx. 2 to 3°) leads to measuring errors if the steepness of the filter edges is in excess of 2 db per c/s, e.g. in the case of narrow filters with a pass band width below 100 c/s. This fault of the level oscillator can be eliminated by simply replacing some capacitors and resistors by reference to the "Fault Eliminating Section", page 16.

J. Connection of Recording Equipment

1. High-resistance recorders, R > 100 kΩ.

Such recorders must be connected to the jacks "Output-" (middle jack) and c (chassis, upper jack). With an indication of 0 db, a voltage of +4 v with respect to the jack c is applied to jack a.

2. Low-resistance recorders R < 10 kΩ

Such recorders must be connected to the jacks "Output-" a (middle jack) and b (lower jack). With an indication of 0 db, the current flowing from a to b is approx. 80 µa.

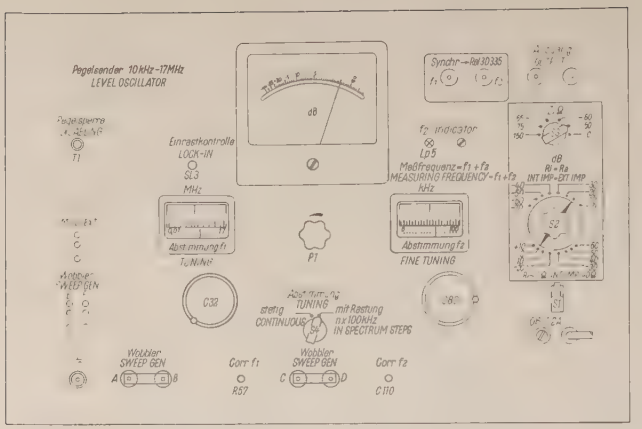
3. Other recorders.

If the input of a recorder having a resistance between 10 and 100 kΩ is connected to chassis with one terminal or if its DC resistance with respect to chassis is $\leq$ 100 kΩ, its input must be built out to 50 kΩ by a series or shunt resistor. Connect the recorder to the jacks "Output-" a and c and insert additionally a dummy plug into jack b so that R10 is disconnected.

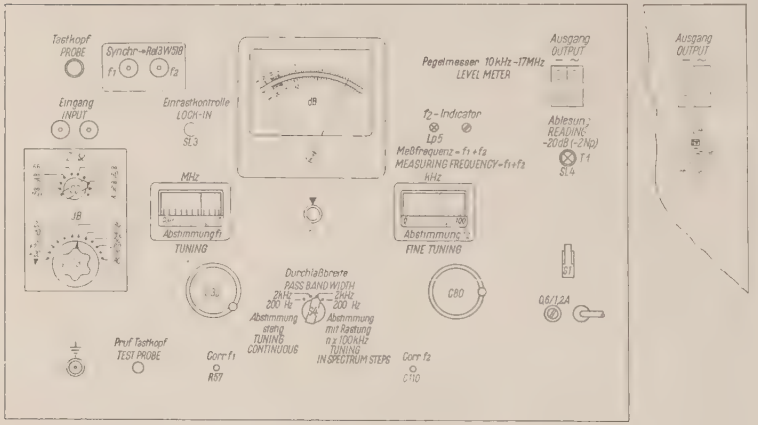
V. ANNEXED FIGURES

This section combines:

	Annexed Fig.
Panel views	1
Typical measuring setups	2
Typical measuring setups	3
Typical measuring setups	4
Typical measuring setups	5



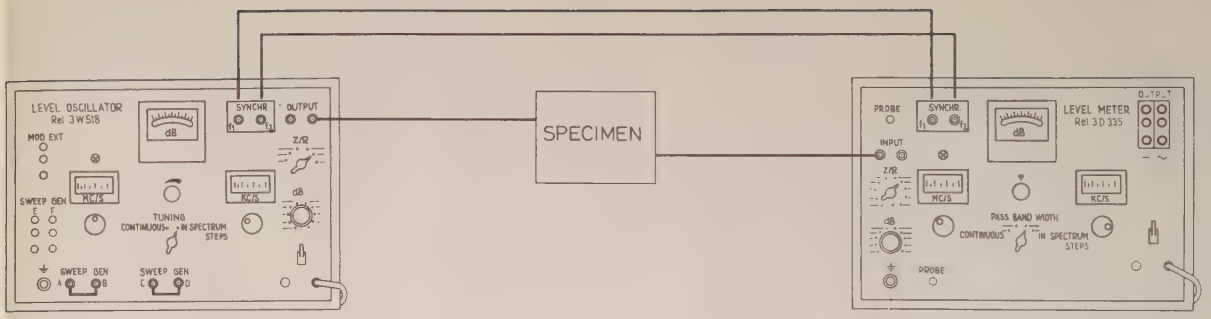
a. Pegelsender / LEVEL OSCILLATOR Type Rel 3 W 518d..., e



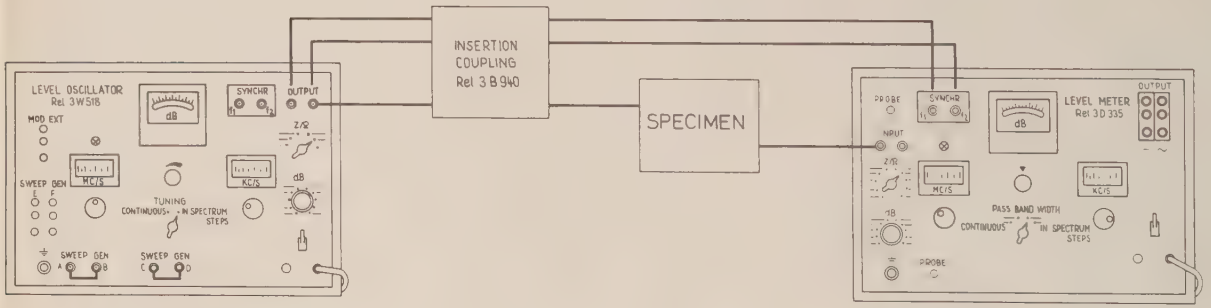
b. Pegelmesser / LEVEL METER Type Rel 3 D 335d... Rel 3 D 335e...

Frontansichten
PANEL VIEWS

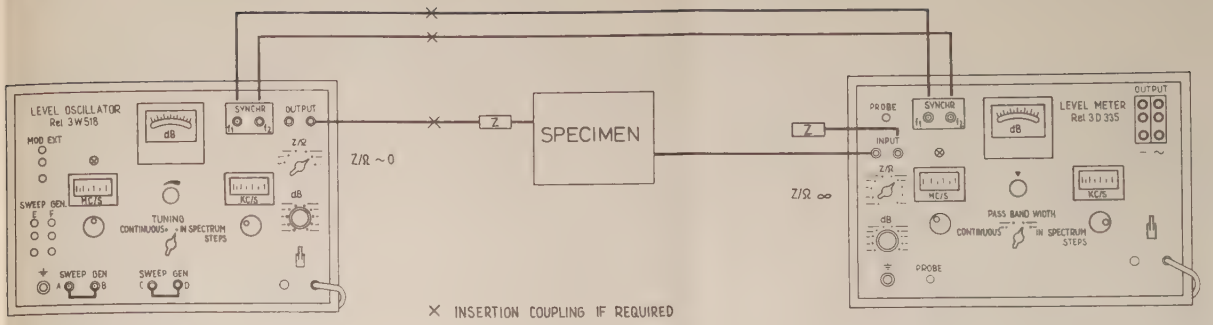
Bildanlage 1
ANNEXED FIG. 1



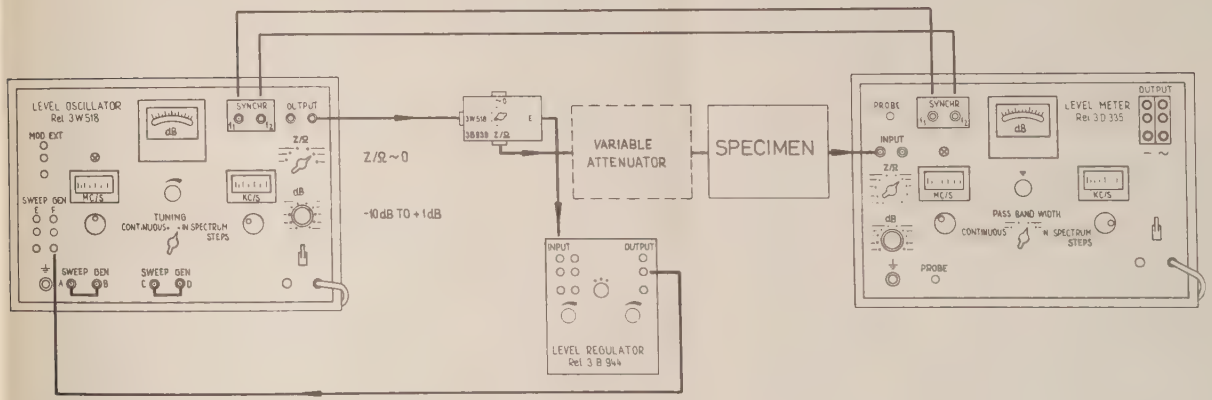
a. GENERAL MEASUREMENTS OF LEVEL, ATTENUATION, AND GAIN



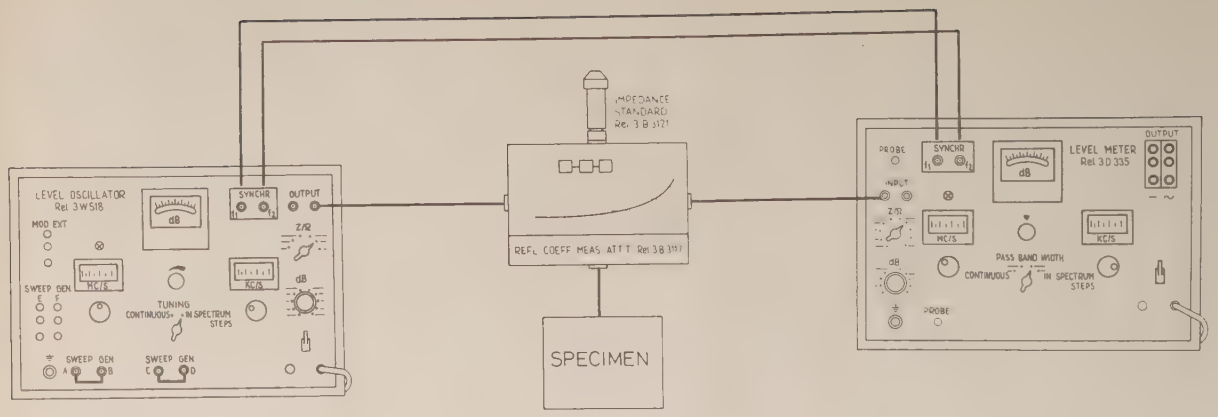
b. MEASUREMENTS OF HIGH ATTENUATIONS



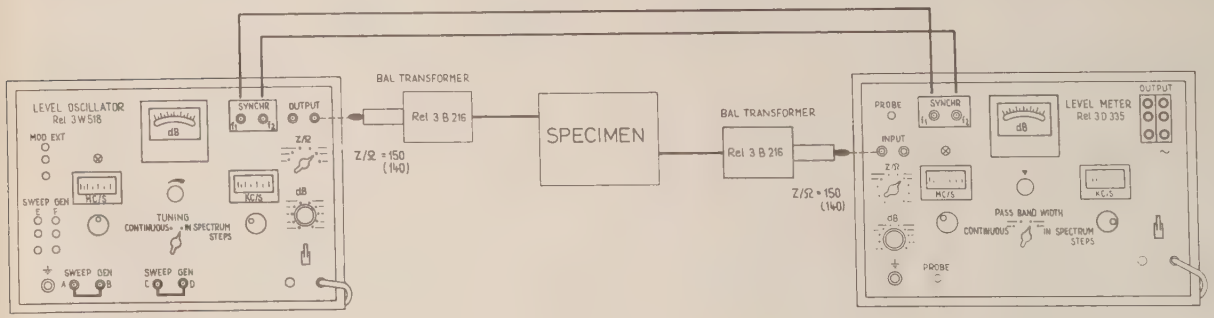
a. MEASUREMENTS OF LEVEL, ATTENUATION, AND GAIN WITH ARBITRARY IMPEDANCE VALUES



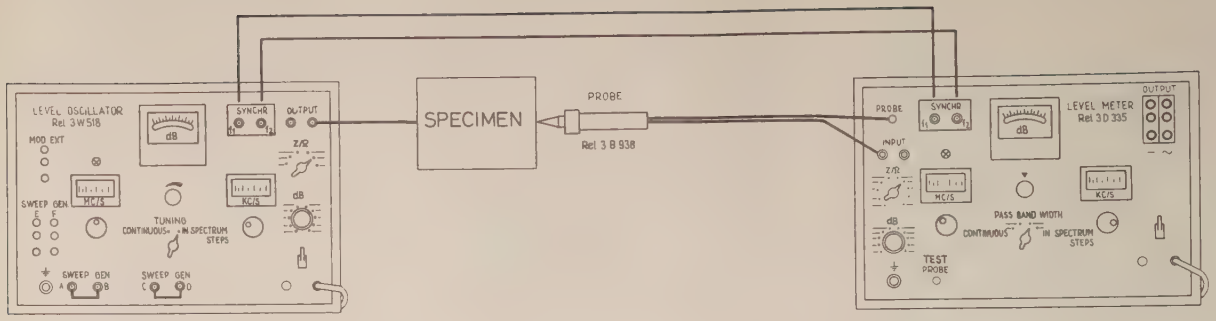
b. MEASUREMENTS WITH HIGHLY CONSTANT TRANSMITTING LEVEL (VIA MEASURING PROBE AND REGULATING AMPLIFIER)



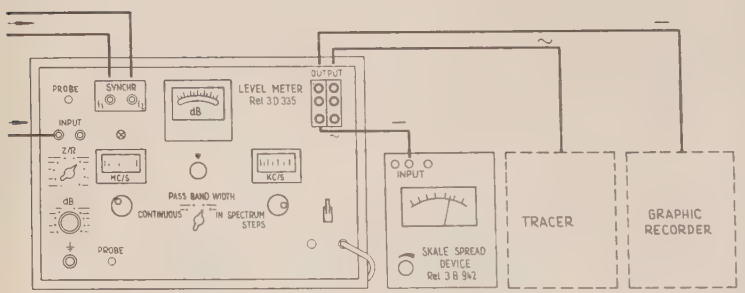
a. MEASUREMENTS OF SIGNAL-TO-REFLECTION RATIOS (WITH REFLECTION COEFFICIENT BRIDGE Type Rel 3 K 132)



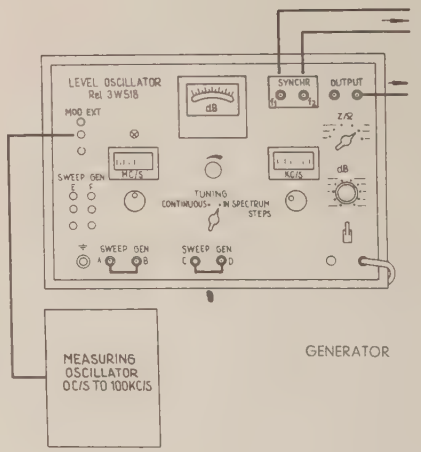
b. MEASUREMENTS OF LEVEL, LOSS, AND GAIN ON BALANCED SPECIMENS (WITH BALANCING TRANSFORMERS)



a. LEVEL MEASUREMENTS WITH HIGH-IMPEDANCE PROBE



DETECTOR



GENERATOR

b. CONNECTIONS OF ATTACHMENTS

N O T E S O N M A I N T E N A N C E

The devices are so designed that no scheduled maintenance work, routine supervision and checking of the tube currents are necessary.

However, in the course of time, aging effects may change the optimum adjustments. No special knowledge is necessary for readjustments of this kind. Provided that the following remarks are carefully observed, this work can be entrusted even to personnel that has not been specially trained. The measuring points and aligning controls are so arranged that no further dismounting is necessary, after the withdrawal of the chassis from the casings.

I. TUBE REPLACEMENT

Proper performance of the devices is based on tubes whose characteristics correspond to the specified data.

If the performance of the devices seems to be impaired, the tubes should be checked first, especially when the frequency scales are no longer correct (see section II).

Since the characteristics of the employed tubes influence to some extent the alignment of the RF circuits, the tubes, should be reinserted at the same place of the device after the test, if possible.

Long operation at a low mains voltage as well as aging phenomena may decrease the emissivity of the tubes. This may cause the spectrum facilities to fall out of step above 15 mc/s (the green lamp "Lock-in" lights continuously when, above 15 mc/s, scale f1 is rotated through its full range).

Replacing the Twin Diode E 91 AA (Tube 21)

After replacement of the twin diode E 91 AA, the mixer circuit Md2 in oscillator 1 must be checked and realigned, if necessary. S4 must be operated to "Tuning In Spectrum Steps".

Adjust the control "Tuning f_1" to a frequency near 15 mc/s so that the green lamp "Lock-in" does not light. Connect a high-impedance DC voltmeter with $R \geq 50,000\ \Omega$, e.g. the Siemens- µa-Multizet 50,000 Ω/v in the 30-v range, between the measuring point M8 and chassis (see Rel ms 35 W 463, sheet 2 or Rel ms 35 D 328d1a, sheet 2).

First adjust potentiometer R65 for minimum voltage at M8 (below tube 22, see Rel ms 35 W 463, sheet 2 or Rel 35 D 328d1a, sheet 2). Then rotate it clockwise until the voltmeter indicates 12.5 v.

Caution: This voltage is also available when the potentiometer is rotated counterclockwise. In this case the regulating amplifier does not work, however.

II. REALIGNING THE FREQUENCY SCALES

A. Realigning the Frequency Scale f_1 (With Tuning in Spectrum Steps)

Operate S4 to "Tuning In Spectrum Steps".

When the lock-in (lighting of the "lock-in" lamp) does not take place at the 100-kc/s divisions of the scale, rotate the control through its full range, beginning with the low frequencies, and determine the direction of the scale deviation from the spectrum, which increases as the frequencies rise. Then make the scale division of 15 mc/s coincide with the index. If the true lock-in point is above (below) the related scale division, rotate the control "Corr. f_1" (accessible at the front panel) counterclockwise (clockwise) until the green lamp "Lock-in" lights up.

B. Readjusting the Frequency Calibration f_1 "Continuous"

1. Level Oscillator

Withdraw the chassis from the casing and place it so that the lower side is accessible.
Operate switch S4 to "Continuous Tuning".

Bring the control "Tuning f_1" exactly to the 15-mc/s line. Operate the control "Fine Tuning f_2" to 0 kc/s.
Tune for an output frequency of 15 mc/s with the potentiometer R82 (for the position see Rel ms 35 W 463 .., sheet 1). For this purpose connect the level meter, exactly adjusted to 15 mc/s, to the output (with tuning in spectrum steps, pass band width 2 kc/s) and align for maximum deflection.

2. Level Meter

Withdraw the chassis from the casing and place it so that the lower side is accessible.
Operate S4 to "Continuous Tuning" and feed a signal of exactly 15 mc/s. Bring "Tuning f_1" exactly to the 15-mc/s divison, and "Fine Tuning f_2" to 0 kc/s. Align for maximum indication on the instrument with potentiometer R82 (for its position see Rel ms 35 D 328 ..., sheet 1).

C. Setting the f_2 Indicator

If the green lamp "f_2 Indicator" fails to light (although not damaged) or if it goes out, as the frequency scale f_2 is rotated, the potentiometer R2 (beside the lamp) must be adjusted.

On the level oscillator: Set the scales f1 (tuning in spectrum steps) and f2 to 0 c/s. Rotate R2 to a medium position (not to the end position) so that the green lamp "f_2 Indicator" lights. With the fine tuning control f_2 align for zero beat (reading $-\infty$).

On the level meter: Operate the level range switch and the frequency scales to ▼ (tuning in spectrum steps). Rotate R2 to a middle position (not to the limit position) so that the green lamp "F2 Indicator" lights and calibrate the level meter.

Subsequently rotate on both devices the potentiometer R2 slowly counterclockwise until the green lamp goes out; rotate R2 now slowly clockwise until the green lamp goes on. Mark this setting (with pencil) at the circumference of the hole for R2 on the front panel. Subsequently rotate R2 onward in a clockwise direction, until the green lamp goes out. Subsequently rotate R2 slowly counterclockwise until the green lamp goes on. Mark this position also. At the edge of the panel hole the two marks will be about 1 mm apart. Set R2 now to the middle between the two marks and close the hole for R2 with a cap. Rotate the scale f2 from start to end, the lamp must not go out; if it does, make the further checks according to sect. II.A.2c.of the Fault Eliminating part.

III. REPLACING THE INDICATING LAMPS (lock-in check, f2 indicator, film scale light)

The indicating lamps are provided with a bayonet socket and can be pulled out by pushing the lamp into the socket, simultaneously twisting it somewhat. (This is best done with a lamp extractor).

The indicating lamps Lp3 "Lock-in" and Lp5 "f_2 Indicator" are externally accessible after withdrawal of the green lamp cap.

For the replacement of the lamps for the film scales, the chassis must be withdrawn from the casing. Then pull out the lamp inclusive of the socket from the rear wall of the film box and insert the new lamp as described above. The ordering designation for the indicating lamps is Fg lp 62b,c.

CARRIER-FREQUENCY LEVEL MEASURING SETUP 17 MC/S
Type Rel 3 W 518d,e/3 D 335d,e

Fault Locating • Fault Eliminating

Fault Locating

I. Locating Faults on the Deenergized Device 1
II. Locating Faults on the Energized Device 2
III. Fault Locating Table for the Level Oscillator 4
IV. Fault Locating Table for the Level Meter 8

Fault Eliminating

I. General Notes 1
II. Level Oscillator
A. Test Instructions 3
B. Additional Information 12
III. Level Meter
A. Test Instructions 17
B. Further Information 33
IV. Annexed Figures 47

The Fault Locating part shows how to track faults right down to the subassembly or component part involved. The Fault Eliminating part gives detailed instruction for testing and aligning work with the repair service.

FAULT LOCATING

I. LOCATING FAULTS ON THE DEENERGIZED DEVICE

1. First of all check the setup by reference to the annexed figures 2 to 5 (Instructions for Use). Check all connecting cords, checking especially if the plugs are firm and in good condition (e.g. continuity of wires and shield).

2. Check the mains use of the faulted device.

3. Check whether a fault in operation of the instruments has been made.

4. Withdraw the chassis of the faulty instrument from its casing by loosening the blank screws with the front panel in horizontal position, putting the front panel subsequently in a vertical position, and carefully pulling out the slide-in chassis by its handles.

5. Carry out a visual examination.

   Overloaded resistors and coils are often conspicuous by their discoloration (even their smell). Find out the fault and eliminate it before replacing such parts, e.g. by checking the capacitors situated in the neighboring circuitry for short-circuits.

   Broken wires can either be seen or be detected by slightly moving them. Withdraw the plugged connecting cords between the subassemblies (loosen the cap nuts) and check whether they are in a proper condition. Also check all tubes, crystals, and modulators whether they are seated properly and firmly in their sockets.

II. LOCATING FAULTS ON THE ENERGIZED DEVICE

Caution.- When the exposed chassis is connected to the mains, the respective safety regulations (e.g. in Germany those of the Association of German Electrical Engineers (VDE) about electrical operating rooms) must be adhered to. Such work should only be carried out by skilled personnel.

Required Measuring Instruments

Multi-DC-voltmeter $\geq$ 50 kΩ/v

e.g. the Siemens microampere-Multizet meter (M-Cat.No.231 252)

Multi-RF-diode or tube voltmeter

e.g. the Siemens RF-Multizet meter (M-Cat.No.231 314)

Advisable:

1 cathode ray oscilloscope

The most interesting information for fault locating is contained in the test diagrams (annexed figures 1 to 9) and the test instructions in the "Fault Eliminating" section. The fault locating tables specify the diagrams and sections to be consulted in each particular case.

If the observed type of fault is mentioned in the following fault locating tables, trouble shooting can often be markedly simplified by proceeding according to the information given there. At the end of these tables space has been provided for your own observations. We would be very grateful if you let us have such additional remarks for mimeographing to the benefit of other users.

The note "Check Forward and Inverse Resistances" of crystal diodes means a simple measurement with a DC ohmmeter. If the check reveals a distinct difference between the forward and the inverse resistance, the diode will be in order to a first approximation. Exact subsequent measurements of the respecitve characteristics will, of course, yield more accurate information.

In the fault locating diagrams (annexed figures 5 and 6) the level data apply for a direct injection of the measuring voltage with the level oscillator Type Rel 3 W 518, i.e. for a direct connection of the level

oscillator output to the injection point, i.e. switch S3 at Z/Ω = 0, the injection level being adjusted with S2 and P1.

On the other hand, the level data in the circuit diagrams apply to injection via an attenuator pad of Z = 75 Ω.

The question "Is fault cleared?" assumes that a fault has been found and eliminated by reference to the "Fault Eliminating" section. For locating defective components the associated circuit diagram is stated, which can be found in the circuit diagram section. All voltages mentioned in the circuit diagrams are mean values ascertained by measurements with the above Siemens Multizet meters. Unless other tolerances are specified, they may vary by about ±15 %.

The location of the subassemblies and individual components is facilitated by the wiring diagrams (Rel ms .. En) in the folder containing the parts list and the circuit diagrams. Comparison with the photographs of the chassis and their subasemblies, associated with the parts list, facilitates the familiarization with the method of representation employed for the wiring diagrams.

III. FAULT LOCATING TABLE FOR THE LEVEL OSCILLATOR Type Rel 3 W 518

Type of Fault	Fault Locating[+]
Output voltage completely missing (both in operation "Continuous Tuning" and "Tuning in Spectrum Steps"). No meter deflection. Frequency spectrum facilities fail to work.	Consult annexed Fig.1
Although the device still operates, the required level can no longer be set (level is low by approx. 5 db/0.5 N or more).	Check the tubes 2 to 9. If the tubes are in order, locate the fault by reference to annexed Fig. 1.
The meter indication fails to agree with the delivered output level, but the fault is not frequency-dependent.	See Fault Eliminating part, page 9 and 11, section II.A.4 and 6.
The meter indication is frequency-dependent.	See Fault Eliminating part, page 9, section II.A.4.
Output level varies considerably.	Check the tubes 4 to 9 and the capacitors C44, C46, C55, C65 in the modulator and amplifier sub-assembly Type Rel 35 W 465. If the fault cannot be eliminated in this way, locate it by reference to annexed Fig.2
Faults occur with measurements on filters with a narrow pass band (< 100 c/s) and a very steep attenuation-vs.-frequency curve (> 2 db per c/s)	See the Instructions for Use part page 12, section IV.H, and the Fault Eliminating part, page 16, section II.B.3.
Excessive frequency response of the output level (without re-adjustment)	Check the tubes 4 to 9. If the fault persists, see the Fault Eliminating part, page 9, section II.A.4.c.

[+] Abbreviations used in the text:
CW = clockwise
CCW = counterclockwise

Type of Fault	Fault Locating
Output level has a frequency response of $\geq$ 2 % when the control "Fine Tuning f_2" is rotated through its range (without readjusting the fine control P1).	See the Fault Eliminating part, page 9, section II.A.4.c.
Output level drops considerably with low mains voltage	Check the tubes 4 to 9. If the tubes are in order, continue the check by reference to annexed Fig. 2. If the fault persists, check the power supply unit by reference to Rel str 35 W 467. Replace the stabilizer tube, if necessary.
Zero-cycle calibration is no longer feasible, indicator lamp fails to light up.	Check the setting of the f_2-indicator by reference to the Fault Eliminating part, page 5, section II.A.2.c. If this is of no avail, check the interpolation oscillator by reference to annexed Fig. 4 and the Fault Eliminating part, page 5, section II.A.2.
Indicator lamp goes out when the control "Tuning f_2" is rotated through its range. Readjustment according to Notes on Maintenance, page 4, section II.C is no longer possible.	See the Fault Eliminating part, page 5, section II.A.2.c and the annexed Fig. 4. For checking relay F see the Fault Eliminating part, page 41, section III.B.6h.
Frequency scale f_1 "Tuning in Spectrum Steps" is no longer correct. Fault increases at high frequencies.	See the Notes on Maintenance, page 3, section II.A. and the Fault Eliminating part, page 7, section II.A.3.b.
Frequency scale f_1 "Continuous Tuning" is no longer correct.	See the Notes on Maintenance, page 3, section II.A. and the Fault Eliminating part, page 8, section II.A.3.c.
Control "Tuning f_2" is detuned.	See the Fault Eliminating part, page 5, section II.A.2. and page 7, section II.A.3.a.

Type of Fault	Fault Locating
Frequency spectrum facilities fail completely. The lamp "Lock-in" lights continuously or not at all. Frequency spectrum facilities fail sometimes at high frequencies. The device still works with "Continuous Tuning".	1. Check relay C, see the Fault Eliminating part, page 12, section II.B.1.a. 2. Check tube 11, see the Fault Eliminating part, page 4, section II.A.1.b. 3. Check tube 22 (E 91 AA), see the Notes on Maintenance, page 1, section I. Check and, if necessary, readjust the voltages specified there even when the tube is not replaced. 4. If the fault persists, locate it by reference to annexed Fig. 3.
Frequency spectrum facilities fail completely. Instrument fails to work even with "Continuous Tuning".	Check tube 11. For this purpose see the Fault Eliminating part, page 4, section II.A.1.b. and c. If the fault persists, locate it by reference to annexed Fig. 3.
Frequency spectrum facilities give a marginal performance, but are unstable. Relay C flutters and the lock-in lamp flickers.	Set the control "Tuning f_1" to 16 mc/s with tuning in spectrum steps. Measure the DC voltage at M8 with respect to chassis (high-impedance > 50 kΩ) when tuning through the 16-mc/s lock-in range (corresponds to the lighting range of the lock-in lamp). If this voltage varies by ΔE = 1 to 2 v, set f_1 to the spectrum point "0 MC/S". In this case ΔE must be 8 to 12 v in the lock-in range. If such is not the case, locate the fault by reference to annexed Fig. 3. When the voltage varies as specified, relay C must be checked. See the Fault Eliminating part, page 12, section II.B.1.a.
The instrument fails to work with synchronization of f_1 or f_2.	See page 8, section IV of the fault locating table for the level meter.

Type of fault	Fault Locating
The frequency scale f_1 or f_2 or both are shifted by the same amount throughout the frequency range. When they are rotated through their range, the transport of the film is irregular and jerky.	The perforation of the respective film is torn up. For replacement of this film, see the Fault Eliminating part, page 13, section II.B.2.
Fine drive for scale f_1 fails to transport the scale properly.	See annexed Fig. 11. If no improvement is possible, check whether the film guide is dirty. For this purpose see the Fault Eliminating part, page 13, section II.B.2.
Output level can no longer be adjusted with the rotary control "Transmitting Level - Fine Control", this control turns very easily. Potentiometer Type Rel 35 W 465 is no longer controlled.	String drive (rubber ring) at the upper side of Rel 35 W 465 is torn. Ordering designation: Cord ring 24x8 for Rel send 118a.

IV. FAULT LOCATING TABLE FOR THE LEVEL METER Type Rel 3 D 335

Type of Fault	Fault Locating
Measuring and calibrating are impossible, even with "Continuous Tuning". Spectrum facilities fail.	Carry out the check by reference to annexed Fig. 7. If the frequency spectrum facilities are again in order, but the fault persists, proceed as follows:
Measuring and calibrating are impossible (there is no indication on the instrument), but the frequency spectrum facilities work.	Check the setting of the f_2-indicator. See the Fault Eliminating part, page 19, section III.A.2.c.
Measuring and calibrating are impossible. Frequency spectrum facilities still work. Functioning of f_2-indicator is faulted. Indicator lamp fails to light up.	Check relay F, see the Fault Eliminating part, page 41, section III.B.6.h. If the fault persists, examine the interpolation oscillator, see the Fault Eliminating part, page 19, section III.A.2.
Calibration is possible, but level indication is in error.	See the Fault Eliminating part, page 23, section III.A.4. If the maximum variation of R18 is not sufficient, replace tube 13 and check oscillator 10 by reference to Rel str 35 D 328..., sheet 1. Under no circumstances must the resistors R12 to R17 be varied.
Calibrating voltage is available, but the gain of the instrument is too low. The calibrating mark on the instrument can hence no longer be adjusted with the control "P".	Check by reference to the Fault Eliminating part, page 34, section III.B.4. If the tubes mentioned there are in order, check the tubes 4, 9, 10 in the superheterodyne unit. If they are in order, too, proceed by reference to the annexed Fig. 6.
The indication varies considerably in the presence of shocks (up to 10 db/1 N).	See the Fault Eliminating part, page 28, section III.A.7.c.2.

Type of Fault	Fault Locating
The indication varies slightly in the presence of shocks (1 to 2 %) and/or the parasitic deflection on the instrument is excessive.	See the Fault Eliminating part, page 34, section III.B.2.c. If the fault cannot be located in this way, proceed by reference to page 28, section III.A.7.c.1. (50-kc/s band pass filter) and c.2 (1.5-mc/s band-pass filter), and page 34, section III.B.4. (modulator 2). Consult also page 31, section III.A.10. (residual distortion).
Conspicuously high parasitic deflection when the control "Tuning f_1" is adjusted to 300 and 600 kc/s (f_2 at 0 kc/s) when the input is open and S3 at ∞ .	See the Fault Eliminating part, page 31, section III.B.9.
Indication depends considerably on mains voltage variations.	1. Check the power supply unit by reference to Rel str 35 D 331. 2. Check the tubes 1 and 2. See the Fault Eliminating part, page 34, section III.B.4. 3. Check the tubes 9 and 10 in the superheterodyne unit Type Rel 35 D 340.
In measurements with "Pass Band 2 kc/s", the level indication fails to agree with the level indication in the position "Pass Band 200 c/s".	See the Fault Eliminating part, page 25, section III.A.4.c.
The indication in the range 1 to 16 mc/s is frequency-dependent.	See the Fault Eliminating part, page 23, section III.A.4.b.
The indication in the range 30 to 50 kc/s is frequency-dependent (up to about 10 %). At high frequencies it increases by about 10 % or more.	See the Fault Eliminating part, page 35, section III.B.5.

Type of Fault	Fault Locating
The indication is frequency-dependent by more than ±3 %, depending upon the adjustment of the control "Fine Tuning f_2".	See the Fault Eliminating part, page 34, section III.B.4.
The fault occurs in measurements with filters of a narrow pass band (< 100 c/s) and a very steep attenuations-vs.-frequency curve (> 2 db per c/s).	See the Instructions for Use, page 12, section IV.H. and the Fault Eliminating part, page 34, section II.B.3.
In certain steps the range switch fails to transfer or transfers improperly.	See the Fault Eliminating part, page 25, section III.A.5. and page 35, section III.B.6.
Upon actuation of key T1 "Reading -20 db/-2 N" or of switch S7 the indication is in error.	See the Fault Eliminating part, page 34, section III.B.3.
The frequency scale f_1 "Tuning in Spectrum Steps" is no longer correct. The fault increases at high frequencies.	See the Notes on Maintenance, page 3, section II.A. and the Fault Eliminating part, page 21, section III.A.3.b.
The frequency scale f_1 "Continuous Tuning" is no longer correct.	See the Notes on Maintenance, page 3, section II.B.2. and the Fault Eliminating part, page 22, section III.A.3.c.
The frequency scale f_2 is detuned	See the Fault Eliminating part, page 19, section III.A.2.a. and page 21, section III.A.3.a.
The f_2-indicator lamp goes out when the scale f_2 is rotated through its range. Readjustment according to Notes on Maintenance, section II.C. is not possible.	See the Fault Eliminating part, page 19, section III.A.2.c. and annexed Fig.8. Check relay F, see the Fault Eliminating part, page 41, section III.B.6.h.

Type of Fault	Fault Locating
The frequency spectrum facilities fail to work. The lock-in lamp lights continuously or not at all. With "Continuous Tuning" the instrument works or the frequency spectrum facilities fail sometimes at high frequencies.	1. Check relay C. See the Fault Eliminating part, page 39, section III.B.6.e. 2. Check tube 11 and oscillator 1. See the Fault Eliminating part, page 17, section III.A.1.b. 3. Check tube 22 (E 91 AA). For this purpose see the Notes on Maintenance, page 1, section I. Check the voltages for tube 22 specified there and readjust them even when it is not replaced. If the fault persists, locate it by reference to the annexed Fig. 7.
The frequency spectrum facilities fail completely. The instrument fails to work even with "Continuous Tuning".	Check tube 11 and oscillator 1; see the Fault Eliminating part, page 17, section III.A.1.b. If the fault persists, locate it by reference to the annexed Fig. 7.
The frequency spectrum facilities give a marginal performance, but are unstable. Relay C flutters, and the lock-in lamp flickers.	Measure the DC voltage at M8 (high impedance $\geq$ 50 kΩ/v) (see Rel str 35 D 328, sh. 1) and adjust the control "Tuning f_1" to 16 mc/s with tuning in spectrum steps. When one traverses the 16-mc/s lock-in range (the lamp "Lock-in" must light in this case), the voltage shall vary by ΔE = 1 to 2 v. Set f_1 to the spectrum point 0-mc/s. In this lock-in range the voltage shall vary by ΔE = 8 to 12 v. If such is not the case, locate the fault by reference to the annexed Fig. 7. If the voltage varies as specified, check relay C. See the Fault Eliminating part, page 39, section III.B.6.e. and annexed Fig. 9
With synchronization of f_1 the instrument fails to work.	Check relay E. See the Fault Eliminating part, page 41, section III.B.6.g. If this relay is performing properly, check in the power supply unit 35 W 467 of Rel 3 W 518 the connection between transformer Ü1 at tube 1 to the

Type of Fault	Fault Locating
	output jack "Synchr. f_1". For this purpose see the circuit diagram Rel str 35 W 467.
With synchronization of f_2 the instrument fails to work.	See the Instructions for Use, page 9, section IV.F. If the device still fails to work, check relay D by reference to the Fault Eliminating part, page 40, section III.B.6.f. If this transfer is in order, check in the level oscillator Type Rel 3 W 518 the connection from the output "Synchronization f_2" to tube section 20^1 in the interpolation oscillator (see Rel str 35 W 463, sheet 2). If no fault can here be located either, check the frequency of the oscillator 20 (19.3 mc/s) in the level meter (Fault Eliminating part, page 19, section III.A.2.a.) and that of the oscillator unit 20 (20.8 mc/s) in the level oscillator (Fault Eliminating part, page 5, section II.A.2.a.).
Excessive residual distortion	See the Fault Eliminating part, page 31, section III.A.10.
Image-frequency rejection too low.	See the Fault Eliminating part, page 29, section III.A.8.
The frequency scale f_1 or f_2 or both are shifted by the same amount throughout the frequency range. When the scales are rotated through their range, the transport of the film is irregular or jerky.	The perforation of the respective film is torn. For replacement of the film see the Fault Eliminating part, page 42, section III.B.8.
The fine drive for scale f_1 fails to transport correctly.	See annexed Fig. 11.

I. GENERAL NOTES

The elimination of faults is based on the folder containing the parts lists and circuit diagrams. When replacing faulty components, do not change the position of the wires, if possible. Unless unsoldered wires can be discriminated unambiguously by their color, mark them e.g. by pasted-on paper tags. Be careful in making new soldering joints.

Exercise great care in replacing semiconductors (e.g. crystal diodes) in order to avoid cracks at the lead seals which often consist of glass. Bend the wires round an edge, e.g. use flat-type pliers (Fig.1).

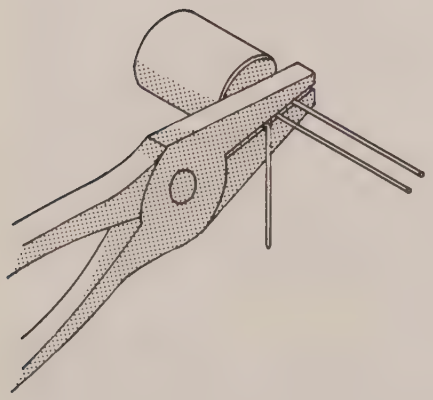


Fig. 1 DO NOT BEND THE TERMINAL WIRE RIGHT AT THE GLASS SEAL, BUT ROUND AN EDGE, E. G. THAT OF FLAT-TYPE PLIERS

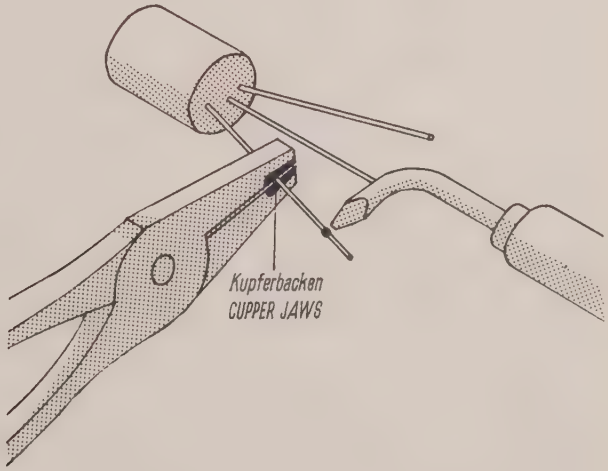


Fig. 2 FOR CARRYING AWAY THE SOLDERING HEAT, FLAT-TYPE PLIERS WITH COPPER JAWS ARE RECOMMENDED

Semiconductors as well as deposited-carbon resistors and plastic foil capacitors are highly temperature-sensitive. Therefore their terminal wires must not be shortened. Take care that the soldering heat is well removed e.g. as shown in Fig.2. For semiconductors a low-melting solder, e.g. the Fluitin solder wire Type P with 60 % tin and resin core should be used.

The following sections II.A. and III.A. contain complete test instructions for checking the electrical values, divided up into level oscillator part and level meter part. Routine examinations can also be based on these instructions. The sections II.B. and III.B. give information on the elimination of faults in the relay circuits and the drives of the variable capacitors.

II. LEVEL OSCILLATOR Type Rel 3 W 518

A. Test Instructions

These instructions describe all essential measurements for checking the electrical values and contain notes about the elimination of faults. This makes them especially suited as a basis for periodical routine examinations. For eliminating a detected fault only those sections need be observed to which reference is made in the Fault Locating part.

Required Measuring Instruments:

a. 1 frequency measuring device 100 kc/s to 21 kc/s, error $\pm 1 \times 10^{-6}$

b. 1 frequency meter 100 kc/s to 210 kc/s, error $\pm 1 \times 10^{-2}$

c. 1 DC multimeter, $\geq$ 50,000 Ω/v
   e.g. the Siemens µa-Multizet meter, M-Cat. No. 231252

d. 1 RF diode or tube voltmeter,
   e.g. the Siemens RF-Multizet meter, 30 c/s to 450 mc/s, M-Cat. No. 231504

e. 1 calibrating level meter for checking the 0-db/+10-dbm (0-N/+1-Nm) marks with a residual error of $\leq$ 0.05 db (0.005 N) at 1 mc/s

f. 1 variable transformer for setting the exact mains voltage as well as ±10 % overvoltage or undervoltage

g. 1 attenuator, Z = 60, 65 or 75 Ω, permissible error at f = 15 mc/s: ±1 %,
   e.g. the attenuator Type Rel 3 D 117

h. 1 distortion factor measuring unit, e.g. the selective level meter Type Rel 3 D 335

Note: Frequencies and calibrating levels should only be readjusted when the device has reached its operating temperature (i.e. after being operated for more than one hour).

1. Oscillator f_1

(See the circuit diagram Rel str 35 W 463, sheet 1, and the wiring diagrams Rel ms 35 W 463, sheets 1 and 2)

a. Oscillator 10 (100 kc/s)

Connect this oscillator to M1 (regulating lamp RL1) of the frequency measuring device, error $\pm 1 \times 10^{-6}$.

Nominal frequency: 100.000 kc/s, permissible deviation: $\leq \pm 2$ c/s

Can be readjusted with C2. The accuracy of this frequency governs the resultant accuracy of the frequency f_1.

b. Oscillator 1 (21.1 to 38.1 mc/s)

Operate the function switch S4 to the position "Continuous Tuning". Connect the AC voltmeter between the ceramic lead-through unit "e" and chassis. Set the scale f_1 (mc/s) to 0 mc/s (21.1 mc/s at the ceramic lead-through unit "e"). The voltage shall be $\geq$ 0.55 v. Rotate scale f_1 throughout its range (38.1 mc/s at the lead-through unit "e"). The voltage varies by $\pm$0.2 v and should not be less than 0.4 v.

If a fault cannot be eliminated by tube replacement (tube 11), locate it with the aid of the voltage data in the circuit diagram Rel str 35 W 463, sheet 1. Check also the rectifiers 3 and 4 for their forward and inverse resistances.

c. Frequency Spectrum Facilities (for spectrum-step tuning) (Mixer, Tube 22)

Aligning the Regulating Voltage. Operate switch S4 to "Tuning in Spectrum Steps".
Adjust the control "Tuning f_1" to a frequency near 15 mc/s so that the green lamp "Lock-in" does not light up.
Connect a high-impedance DC voltmeter of Zi $\geq$ 50,000 Ω between M8 (see Rel ms 35 W 463) and chassis.
The voltage should be 12.5 v.

If the measured voltage deviates from the nominal value, adjust it for a minimum with the potentiometer R65 (above tube 22) as a first step. Then rotate the potentiometer clockwise until the voltmeter reads 12.5 v.

Note: The voltage is available also when the potentiometer is rotated counterclockwise away from the voltage minimum, but in this case the lock-in action will not work.
If it cannot be set, check and readjust all voltages by reference to the annexed Fig.3. For the locations of the alignment controls, see also the parts list, Fig.5, page 23.

Alignment of the Frequency Spectrum Facilities (Required for fault eliminating only). Operate switch S4 to "Tuning in Spectrum Steps". The DC voltage between M5 and chassis shall be 8.0 v (adjustable with "Corr. f_1").

Operate switch S4 to "Continuous Tuning". Connect the RF voltmeter between M6 and chassis. Adjust the frequency scale f_1 for 0 mc/s and align it alternately with C48 for maximum voltage and with C46 for 0.3 v. (Caution - A voltage of 1.5 v DC is simultaneously present).

Rotate the frequency scale f_1 as far as 16 mc/s. During this, the voltage at M6 drops to about 0.05 v.

If other voltage values are measured or if the alignment with C46 and C48 is not possible, check the tubes 12, 15, and 16 (CCa tubes) and the tube 22 (E91AA).

Align the frequency spectrum facilities anew after a tube has been replaced. If the tube 22 (E 91 AA) is replaced, the alignment of the regulating voltage must in any case also be repeated.

If the tubes are in order, but if the fault persists after replacement of a tube, check the wiring (see Rel ms 35 W 463, sheet 1) and locate the fault with the aid of the voltage data given in the circuit diagram Rel str 35 W 463, sheet 1.

2. Interpolation Oscillator

(See the circuit diagram Rel str 35 W 463, sheet 2)

a. Oscillator 20

Connect a frequency meter (with an error of not more than 1×10^{-6}) to M13 (for its location see Rel ms 35 W 463, sheet 2). The frequency shall be 20.80 mc/s and must not deviate by more than $\pm$100 c/s (readjustment with C109). After the alignment the trimmer capacitor C110 (Corr. f_2) shall be enmeshed by at least 1/3.

b. Oscillator 2' (300 to 200 kc/s)

Connect the diode or tube voltmeter to the output "Synchr. f_2".
Set the scale f_2 to 50 kc/s.
The voltage at the output "Synchr. f_2" (250 kc/s) shall be about 2.0 v.
Rotate the scale f_2 throughout its range and measure the frequency at the output "Synchr. f_2". It shall pass through the range 310 to 195 kc/s.

c. Adjusting the f_2-Indicator

Adjust the potentiometer R2 "f_2-Indicator" according to Notes on Maintenance, p.4, sect. II.c.

Note: R2 must be approximately in the middle of the regulating range. Near the stop the lamp may light up as well, but this adjustment is wrong.

Rotate the scale f_2 throughout its range. The indicator lamp f_2 must not go out. Readjust potentiometer R2, if necessary.

If this cannot be achieved, connect a DC voltmeter $\geq$ 50 kΩ/v to the ceramic lead-through unit "g" (see Rel str 35 W 463, sheet 2) and adjust a voltage of 3.0 v with the potentiometer R2. Subsequently measure and adjust all voltages mentioned in annexed Fig.4. For the locations of the aligning elements see also Fig.5 in the parts list. If necessary, check relay E by reference to the instructions in section III.B.6.g, page 41.

If the f_2-indicator fails to perform properly, remove the connection (potentiometer R159 - input of the 150-kc/s low-pass filter) indicated in the annexed Fig.4 and, as a first step, check the wiring of the phase bridge and the discriminator for broken wires, etc. If this is not successful either, check the discriminator.

d. Discriminator (required for fault eliminating only)

Measure the DC voltage between M9 and chassis and adjust it for 1.8 v with R159.

Set the scale f_2 to 40 kc/s. Connect the positive terminal of the DC voltmeter to M9 and the negative terminal to M12 (R116/C97).

Adjust the voltage for 0 v $\pm$0.05 v with R113. Adjust the scale f_2 for 100 kc/s. The voltage should not drop by more than approx. 0.8 v. Adjust the scale f_2 for 0 kc/s, the voltage shall not increase by more than 0.8 v.

If such is not the case or the fault persists, locate it with the aid of the voltage data given in the circuit diagram Rel str 35 W 463, sheet 2. Check the crystal diodes Gr17 and Gr18 for their forward and inverse resistances. If the fault still persists, examine the phase bridge.

e. Phase Bridge (Ü6 - Ü7 - Md5, required for fault eliminating only)

Connect the DC voltmeter between M11 (R115) and M12 (R116). When the scale f_2 is rotated from 0 to 100 kc/s, the indicated voltage shall vary as little as possible within the limits -0.35 and +0.35 v.

Locate the fault with the aid of the voltage data given in the circuit diagram Rel str 35 W 463, sheet 2.

f. Oscillator 2 (required for fault eliminating only)

Connect the RF diode or tube voltmeter between M14 and chassis. Align the oscillator alternately with C125 and L15 for maximum and with C121 for 0.3 v. It is absolutely necessary for this alignment that the interpolation oscillator works, i.e. the lamp "f_2-Indicator" must light up. If it goes out during the alignment, readjust with the potentiometer "f_2-Indicator".

Measure the voltage at the jack d "Output f_2". It shall range between 0.45 and 0.85 v (21 to 21.1 mc/s).

If all voltages are available with the correct values, but the device does not work in spite of this, carry out the check by reference to the annexed Fig.1.

3. Checking the Frequency Scales

a. Frequency Scale f_2

Frequency alignment of generator 2' (300 to 200 kc/s).
Connect the frequency meter (error not exceeding $\pm 1 \times 10^{-2}$) to the output "Synchr. f_2". Set the scale f_2 to 0 kc/s. The frequency at the synchronization output f_2 shall be 300 kc/s.

This frequency can be readjusted with the trimmer capacitor C84 (in phase bridge and discriminator, see Rel str and ms 35 W 463).

Check the scale f_2 according to the following table:

Scale division	0	10	20	30 to 80	90	100	kc/s
Frequency at the output "Synchr. f_2"	300	290	280	270 220	210	200	

Throughout the range of scale f_2 the scale error must not exceed the tolerance of ± 300 c/s.

If the frequency cannot be aligned (e.g. the detuning occurs in the middle of the scale), the variable capacitor must be readjusted.

b. Frequency Scale f_1 with Tuning in Spectrum Steps

Operate the switch S4 to "Tuning in Spectrum Steps", set the frequency scale f_1 for 0 mc/s. The green lamp "Lock-in" must light up.

Adjust the control "Fine Tuning f_2" for 0 kc/s. The indication of the instrument moves to $-\infty$ (zero beat). For aligning the zero beat exactly, the trimmer adjustment "Corr. f_2" must be averaged out between two pointer deflections, or zero beat be monitored with an earphone at the output of the oscillator.

Connect the frequency measuring instrument having an accuracy $\pm 1 \times 10^{-6}$ to the output of the level oscillator and check the calibration of the scale f_1, i.e., all spectrum points. Permissible frequency deviation: $\pm 2 \times 10^{-5}$ ± 300 c/s.

If the scale error increases towards higher frequencies, i.e. the lock-in conditions indicated by the green lamp coincide no longer with the associated scale divisions, note the direction of the deviations, increasing towards high frequencies. Make subsequently the 15-mc/s scale division coincide with the index line. If the true lock-in point is above (below) the associated calibrating division, rotate "Corr. f_1" on the front panel counter-clockwise (clockwise) until the green lamp "Lock-in" lights up. If the range of the trimmer "Corr. f_1" is not sufficient, make the readjustment by carefully changing the setting of C35 (see Rel ms 35 E 463, sheet 2) so that the control "Corr. f_1" is again approximately in the middle of its range.

If the frequency calibration is incorrect all over the scale f_1, repeat the check in accordance with section 1a - oscillator 10 (100 kc/s).

c. Frequency Scale f_1 without Tuning in Spectrum Steps

The frequency meter remains connected to the output of the level oscillator. Operate switch S4 to "Continuous Tuning". The control "Fine Tuning f_2" remains at 0 kc/s.

Set the control "Tuning f_1" to 15 mc/s.

With the potentiometer R82 the frequency at the oscillator output can be readjusted to 15 mc/s. The frequency control "Continuous Tuning" is intended for orienting measurements only. No tolerances have therefore been fixed.

If 15 mc/s cannot be achieved with R82, check the DC voltage of the Zener diode Gr6 (see Rel str 35 W 463, sheet 1). If it is not between 5.5 and 6.5 v, the diode must be replaced.

4. Checking the Meter Indication

a. Indication 0 db/+10 dbm (0 N/+1 Nm) at f = 1 mc/s

Connect an exactly calibrated level meter to the oscillator output. (The calibration of this level meter for the 0-db/+10-dbm (0-N/+1-Nm) mark should be checked before the measurement. The error at 1 mc/s shall be $\leq$ 0.05 db). The internal impedance of the oscillator and the input impedance of the level meter must be set to the same value. The indication of the meter of the level oscillator should also be 0 db/+10 dbm (0 N/+1 Nm). Tolerance $\pm$0.2 db, a readjustment is possible with the variable resistor R3 in the measuring panel (see Rel str, ms 35 W 466).

b. Frequency Response of the Indication (as referred to 1 mc/s)

Operate switch S2 to 0 db/+10 dbm (0 N/+1 Nm), S3 to 75 Ω, terminate the oscillator output into 75 Ω and connect an RF voltmeter (e.g. the Siemens RF Multizet meter, measuring range without DC voltage) to the second level oscillator output.

Note: The frequency response of the voltmeter must be as low as possible in the frequency range 100 kc/s to 15 mc/s.

Rotate through the frequency range 100 kc/s to 15 mc/s with "Continuous Tuning", keeping the indication on the voltmeter constant with the fine control of the level oscillator. The reading of the instrument, as referred to the indication at 1 mc/s, must not change by more than $\pm$2 % throughout the frequency range.

If the deviations are greater, check the wiring and the components in the detector circuit (R1, Gr1, etc.), see Rel str 35 W 466 and Rel ms 35 W 466. If no fault is detected (the reactor L4 is only incorporated when required), the frequency response can be realigned with C1 in the measuring panel Type Rel 35 W 466. Check subsequently whether the instrument reading is still correct (see section a).

c. Frequency Response of the Output Level without Readjustment

To test the dependence of the interpolation oscillator (carrier voltage); use the circuit as under b. The diode or tube voltmeter can be omitted. Adjust the transmitting level to the zero mark on the instrument with the fine control at 1 mc/s. Do not change the position of the fine control afterward.

Rotate the frequency control "Fine Tuning" through its range 0 to 100 kc/s.

The frequency response of the indication should be less than ±3 %.

If it is greater, check the tubes 2 and 3 (CCa) in the modulator and amplifier subassembly Type Rel 35 W 465 as a first step. If they are in order, check the voltage of the interpolation oscillator f_2 at the input of the modulator and amplifier subassembly (jack "a") for stability. It should be 0.35 to 0.7 v. If such is the case, check the transformer Ü4 and C15, C16, see Rel str 35 W 465. If no fault is detected, set the scale f_1 to 2 mc/s. Adjust the meter indication for the zero mark with the fine control P1. Operate the Zi-switch to 0 Ω and terminate the oscillator input into 75 Ω. Rotate the scale f_2 from 0 kc/s to 100 kc/s and realign the trimmer C15 in the modulator and amplifier subassembly for minimum frequency response.

To test the dependence of the spectrum oscillator (control voltage) rotate the oscillator frequency through the range 30 kc/s to 15 mc/s. Permissible frequency response as referred to 1 mc/s:

up to 10 mc/s = ±0.2 db
up to 15 mc/s = ±0.5 db

In the case of an excessive frequency response, the tubes 4 to 9 in the modulator and amplifier subassembly must be checked first. If they are in order, carry out the alignment in the following way.

Set the level oscillator for a level of -10 db (-1 N/0 dbm/0 Nm)
Continuous tuning, and Zi = 0 Ω
Terminate the level oscillator output into 75 Ω
Rotate the control "Tuning f_1" through the range 1 to 15 mc/s.
Realign the frequency response, as referred to 1 mc/s, with C53 and, to a somewhat lesser extent, also with R36 in the modulator subassembly Type Rel 35 W 365 (see Rel str 35 W 465 and Rel ms 465). C53 chiefly affects the upper frequency range.

If the frequency response cannot be aligned, check first the DC voltage at the cathode II of tube 8 (M15) in the modulator and amplifier subassembly Type Rel 35 W 465. It should be 15.5 v (adjustable with R96 in the modulator and amplifier subassembly). If the voltage is present, but no alignment is possible, check the modulator Md2 (Gr8 to 11) in Type Rel 35 W 465.

After the alignment check the frequency response in the positions 0 db (0 N/+10 dbm +1 Nm). If it exceeds the permissible tolerances, average out the most favorable response between these positions with C53.

After the frequency response has been aligned, check the instrument indication in accordance with the sections 4.a, page 8.

5. Mains Voltage Dependence

a. Level Indication

Vary the mains voltage by ±10 %.

The variation of the indication may be about ±0.3 db.

If the variation of the indication is markedly greater, check the tubes 4 to 9. If they are in order, carry out the check by reference to annexed Fig.2. If the fault persists, check the power supply unit by reference to Rel str 35 W 467. Replace the stabilizer tube, if necessary.

b. Frequency (tuning in spectrum steps)

The permissible frequency variation for a mains voltage variation of ±10 % is ±1 x 10^{-6} ±30 c/s

6. Output Divider

a. At f = 1 mc/s

Connect the attenuator and the voltmeter or level meter to the level oscillator output. Observe the impedance termination. Ascertain the fault of the output divider by comparison with the attenuator, starting from the position 0 db, +10 dbm (0 N or +1 Nm).

Permissible error: ±0.2 db (±0.02 N).

b. At f = 10 mc/s

Measuring setup as described under a

Permissible error: ±0.3 db (±0.03 N)

c. At f = 15 mc/s

Same measuring setup, but the error of the attenuator at f = 15 mc/s must be previously found and considered in the measurement.

Permissible error: ±0.6 db (±0.06 N)

7. Measuring the Distortion Factor

At f = 1 mc/s and a transmitting level of 0 db, +10 dbm (0 N or +10 Nm) and with termination into 75 Ω, the distortion factor may amount to up to 1 %. Check this with a distortion meter or by measuring the harmonics with a selective level meter.

If the distortion factor is greater, the tubes 4 to 9 in the modulator and amplifier subassembly must be checked.

B. Additional Information

1. Checking the Relays

a. Checking Relay C (see Rel str 35 W 463)

The relay is controlled by the anode current of tube section 16^{II} in the oscillator subassembly Type Rel 35 W 463.

With "Continuous Tuning" the anode voltage for the tube is interrupted by switch S4 and connected to chassis via a substitution load (R26). Relay C, now deenergized, opens the contacts c^{II} (9-10) and the lamp "Lock-in" is put out of operation.

In operation with "Tuning in Spectrum Steps" the +100-v anode voltage is applied from C18 via switch S4-R92-winding-relay C-R95 to anode II of tube 16. By adjusting the control "Tuning f_1" to a spectrum frequency (n x 100 kc/s), this tube is made to carry current. Outside the lock-in zones, however, an AC voltage (of f = 50 kc/s) is applied to the grid, blocking the tube via the rectifier assembly Gr11, C76, R96, etc. The anode voltage at the tube decreases from 100 v to 55 v and relay C operates. The contacts c^{II} (9-10) close. A chassis connection is thus provided for the lock-in lamp, i.e. it lights to indicate the locked condition.

Operate the function switch S4 to "Continuous Tuning" and connect the contacts 9 and 10 on relay C. The lamp "Lock-in" lights up. If such is not the case, check the lock-in lamp SL3, the 5-v supply to SL3, and the wiring between chassis, the relay C, and the lock-in lamp (see the circuit diagram Rel str 35 W 467 of the power supply unit).

Interrupt the connection of the contacts 9-10 again. The lock-in lamp must go out. If such is not the case, there is a short-circuit between the contacts 9 and 10 on relay C. In this case a makeshift reconnection from the contacts c^{II} to the unassigned contacts c^{I} can be effected (terminal 10 to 7 and 9 to 6). If even now the lamp does not go out, relay C must be replaced.

Transfer the function switch S4 to "Tuning in Spectrum Steps". Slowly rotate the control "Tuning f_1" from one spectrum point to the other. The anode voltage at tube section 16^{II} must now vary from +100 v (off spectrum points) to about +55 v (at spectrum points). At +100 v the relay must drop out and at +55 v it must pull in (the click can be distinctly heard). If no anode voltage at all is present, there is an interruption in the path C18

- switch S4 - relay C - anode. (DC resistance of the relay winding: 1250 Ω ±20 % between the terminals 4 and 1.)

If the voltage fails to vary from 100 v to 55 v, look for the fault on transformer 4 or Gr11 in the lock-in indication amplifier (tube 16) in the intermediate amplifier (tubes 15/16, see Rel str 35 W 463, sheet 1). If the voltage varies as specified, but the relay C fails to transfer, it must be replaced.

b. Relay F_2

See page 41 section III.B.6.h "Relay F" and Rel str 35 W 463.

2. Replacing the Scale Films

If a film of frequency scale f_1 or f_2 is no longer correctly transported, i.e., if it moves in jerks or if it jams when the drive is rotated, the perforation of the film will probably be damaged. New films can be ordered from the factory if the exact type designation and the serial number of the device are specified. Replacing the film is not difficult, it requires careful working, however.

Removing the Film

First of all, the front panel must be removed. For this purpose screw off all rotary controls and the panel meter, then loosen the fastening screws of the front panel. After its removal re-apply the rotary controls for "Tuning f_1" and "Fine Tuning f_2", the panel meter and the knob for the function switch S4 ("Continuous Tuning" or "Tuning in Spectrum Step").

Withdraw the film by reference to annexed Fig.10.

Inserting the New Film

(Stick to the Sequence)

Film f_1 (mc/s)

The film is supplied in a rolled-up form (the lettering for the low frequencies must be readable from the outside).

First of all, remove the dust from the film guide with a soft brush. Then

a. insert the rolled-up film with care vertically into the right-hand holding spring. Note.- The holding spring must not be distorted, or else the film will not transport.

b. Feed the film with care leftward into the guide until the 0-c/s mark matches exactly with the index line on the scale window.

c. Adjust the control "Fine Tuning f_2" on the level oscillator for 0 kc/s and operate the function switch S4 to "Tuning in Spectrum Steps" (CW stop). Do not insert the film as yet.

d. Swing up the pointer of the removed film scale f_1 and adjust it to 0 mc/s of the general scale with the rotary control "Tuning f_1". The lamp "Lock-in" must light up. The indication of the instrument must return to $-\infty$ (zero-cycle calibration). If necessary, adjust zero beat on the instrument by slightly detuning with "Fine Tuning f_2". If this is not possible, the 0-mc/s point of scale f_1 is adjusted one spectrum point too high or too low. In such case shift the scale f_1 left or right by one spectrum point, as the case may be, until zero-cycle calibration is feasible.

e. Set the scale f_2 exactly on the 0-kc/s mark and adjust it with "Corr. f_2" at the front panel for zero beat (indication $-\infty$). Now the position of scale f_2 must not be changed again.

f. Transfer the function switch S4 to "Continuous Tuning" and adjust again zero beat with the control "Tuning f_1". Now the setting of "Tuning f_1" must no longer be disturbed.

g. Swing down the pointer and insert the film box carefully. Do not exert any pressure. The perforation of the film should fall into mesh with the toothed wheel without pressure.

h. Tighten the fastening screws (see annexed Fig.10) and swing the pointer up.

i. Check whether the scale calibration is correct, i.e. whether the film is correctly inserted. Rotate the drive carefully through its range, it must not jam. If during the rotation a somewhat louder noise can be heard or the film passes the scale window not evenly but in undulations, the perforations have obviously failed to engage the toothed wheel correctly.

In this case the film must under no circumstances be advanced, but its insertion be checked again.

k. If the transport of the film is correct, re-apply front panel, meter, and the control knobs.

Film f_2 (kc/s)

The film is supplied in a rolled-up form. The lettering for the low frequencies must be readable from the outside.

First of all, remove the dust from the film guide with a soft brush. Then

a. Carefully insert the rolled-up film vertically into the right-hand holding spring. Note.- The holding spring must not be distorted, or else the film will not transport.

b. Feed the film with care to the left into the film guide until the 0-kc/s mark exactly matches the fiducial line on the scale window.

c. Make the following adjustments on the level oscillator:
Operate the function switch S4 to the position "With Tuning in Spectrum Steps" (CW stop),
adjust the control "Fine Tuning f_1" to 0 mc/s. The lamp "Lock-in" must then light up and the film scale f_1 be not further disturbed.

d. Swing up the pointer of the film scale f_2, with the film box not inserted, and adjust for 0 kc/s with the rotary control "Fine Tuning f_2" (zero-cycle calibration). Now the position of the control "Fine Tuning f_2" must no longer be disturbed.

e. Swing down the pointer and insert the film box carefully. Do not exert any pressure. The perforation of the film must fall into mesh with the toothed wheel without pressure.

f. Insert the fastening screws (see annexed Fig. 10) and swing up the pointer.

g. Check whether the scale calibration is correct, i.e., whether the film is correctly inserted. Then rotate the drive carefully through its range, it must not jam. If during the rotation a somewhat louder noise is heard and if the film transports in jerks or passes the scale window not evenly, but in undulations, the perforation has failed to engage the toothed wheel

correctly. In this case the film must under no circumstances be advanced, but its insertion be checked again.

i. If the transport of the film is correct, re-apply front panel, meter, and the rotary controls.

3. Elimination of any Residual Phase Deviation

Such elimination is only necessary for devices Type Rel 3 W 518d... with serial numbers below 5/754387 if narrow filters with an edge steepness of more than 2 db per c/s are to be measured (see the Instructions for Use, section IV.H, page 12).

In the oscillator subassembly Type Rel 35 W 463d 1a, the following modifications must be made (see Fig. 3):

1. The capacitors C7 and C10 must be replaced by an electrolytic capacitor 2 x 25 µf, 250 v, B 43735 and the bracket Type Rel send 118, T141.

2. Replace the resistor R8, 200 Ω by a resistor with 500 Ω ±5 %, 0.33 w; B 51263 A 500 Ω 5/2,
and the 500-Ω resistor R25 by a resistor of 1 kΩ ±5 %, 0.5 w;
B 51264 A 1 K 5/2.

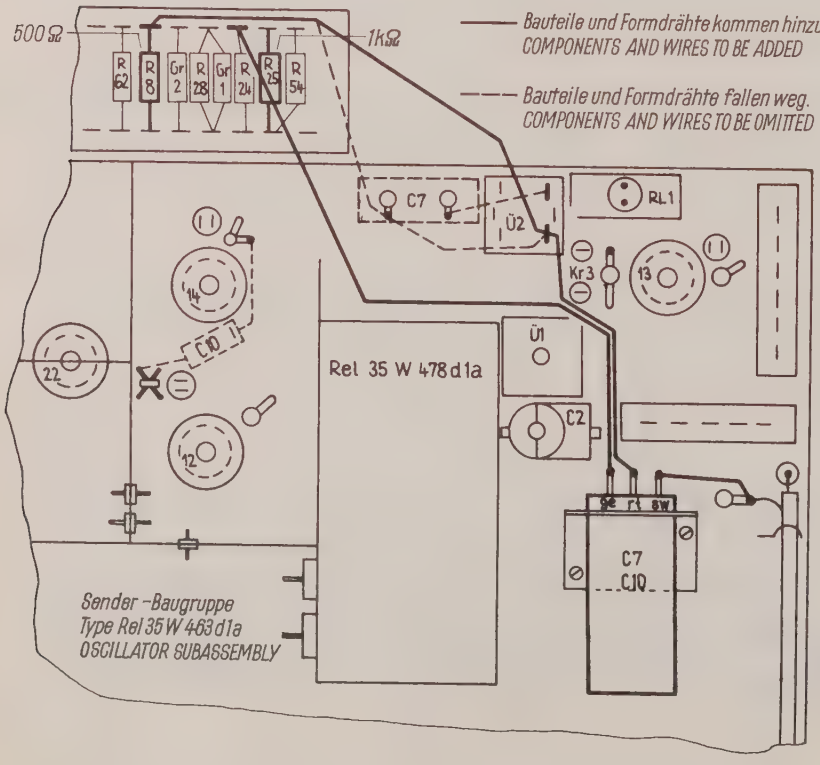


Fig. 3 CIRCUIT MODIFICATION OF DEVICES WITH SERIAL NUMBERS BELOW 5/754387

III. LEVEL METER Type Rel 3 D 335

A. Test Instructions

This section offers instructions for checking and readjusting the electrical data of the level meter. As in the case of the level oscillator, they are simultaneously the basis for periodical checks.

Required measuring instruments:

a-g. As specified in section II.A. on page 3.

h. 1 level oscillator, frequency range 30 kc/s to 15 mc/s e.g. the level oscillator Type Rel 3 W 518

i. 1 low-distortion oscillator (distortion factor $\leq$ 0.01 %) for measuring the residual distortion in the frequency range 30 kc/s to 15 mc/s.

If such an oscillator is not available, the generator voltage must be produced with sufficiently low distortion by using a succeeding low-pass filter or series-resonant circuit for the frequency under test.

1. Oscillator f_1

(See the circuit diagram Rel str 35 D 328 and the wiring diagram Rel ms 35 D 328)

a. Oscillator 10 (100 kc/s)

Connect the frequency measuring device (error 1 x 10^{-6}) between M1 (regulating lamp RL1) and chassis.
Nominal frequency: 100.000 kc/s, permissible error $\pm$2 c/s.
(Adjustable with C2. The accuracy of this frequency determines that of the total frequency f_1.)
Voltage at M1: 0.7 to 0.9 v.

b. Oscillator 1 (21.1 to 38.1 mc/s)

Operate the function switch S4 to the position "Continuous Tuning". Connect the AC voltmeter between the jack "c" (output f_1) and chassis. Set the scale f_1 (mc/s) to 0 mc/s (21.1 mc/s at the jack "c"). The voltage shall be $\geq$ 0.7 v.

Rotate the scale f_1 through its full range. Up to 16 mc/s ($\triangleq$ 37 mc/s at the jack "c"), the voltage should not drop below 0.4 v.

If these values cannot be attained even after tube replacement, locate the fault with the aid of the voltage data in the circuit diagram. Check the rectifiers 3 and 4 for their forward and inverse resistances.

c. Frequency Spectrum Facilities (Mixer Stage - Tube 22)

Aligning the Regulating Voltage

Operate the switch S4 to "Tuning in Spectrum Steps".

Adjust the control "Tuning f_1" to a frequency near 15 mc/s so that the lamp "Lock-in" does not light up. Connect a high-impedance DC voltmeter of Zi $\geq$ 50,000 Ω between M8 and chassis. It should read 12.5 v.

If the measured voltage deviates from the nominal voltage, adjust it first of all for a minimum with potentiometer R65 (about tube 22), then rotate the potentiometer clockwise until the voltmeter reads 12.5 v.

Note: This voltage is also available when the potentiometer is rotated counterclockwise from the voltage minimum. In this case, however, the frequency spectrum facilities will not work.

If the nominal voltage cannot be attained, all voltages must be checked and readjusted by reference to annexed Fig.7. For the location of the alignment controls see also Fig.10 of the parts list.

Realigning the Frequency Spectrum Facilities (required for fault eliminating only)

Operate the switch S4 to "Tuning in Spectrum Steps". The DC voltage at M5 should be 8 v and is adjustable with "Corr. f_1" (R57).

Operate switch S4 to "Continuous Tuning". Connect an RF voltmeter between M6 and chassis.

Set the frequency scale f_1 to 0 mc/s and alternately align C48 for maximum voltage and C46 for 0.3 v.
Rotate the frequency scale f_1 as far as 16 mc/s. The voltage between M6 and chassis drops to about 0.03 v.

If these voltages are not attained, the tubes 12, 15, and 16 (CCa) as well as tube 22 (E 91 AA) must be checked as a first step.

Repeat the alignment after tube replacement. If tube 22 is replaced, the regulating voltage must in any case be aligned anew.

If the fault is not cleared even after the replacement of a tube, check the wiring and locate the fault with the aid of the voltage data in the circuit diagram Rel str 35 D 328, sheet 1.

2. Interpolation Oscillator f_2

(See the circuit diagram Rel str 35 D 328, sheet 2 and the wiring diagram Rel ms 35 D 328)

a. Oscillator 20 (19.3 mc/s)

Connect the frequency measuring device of an accuracy 1 x 10^{-6} between M13 and chassis.

Adjust the frequency to 19.3 c/s as precisely as possible with the trimmer "Corr. f_2" on the front panel. Tolerance: $\pm$100 c/s.

After the alignment the plates of the trimmer "Corr. f_2" should be enmeshed at least by one third. If not so, readjust with C109.

Voltage between M13 and chassis: approx. 0.12 v.

b. Oscillator 2' (300 to 200 kc/s)

Measure the voltage between M10 and chassis with the diode or the tube voltmeter, rotate the scale f_2 through its range. The voltage should remain at $\geq$ 1.4 v.

Measure the frequency at the same measuring point.

When the control "Fine Tuning f_2" is rotated through its range, it should cover the range 310 to 195 kc/s.

c. Adjusting the f_2-Indicator

Adjust the potentiometer R2 (beside the indicator lamp) according to the Notes on Maintenance, p.4, sect. II.c.

Note: The potentiometer must be at about the middle of its range, not near the stop. In the latter case the lamp may light up as well, but this adjustment is wrong.

Rotate the scale f_2 through its range. The indicator lamp must not go out. If this cannot be achieved, connect a DC voltmeter $\geq$ 50 kΩ/v to the ceramic lead-through unit "g" (in the oscillator subassembly Type Rel 35 D 328) and adjust a voltage of 3.0 v with the potentiometer "f_2-Indicator". Then measure and align all voltages specified in annexed Fig.8. For the location of the alignment controls see also Fig.6 of the parts list.

If necessary, readjust the potentiometer R2 or check relay F by reference to section III.B.6.h on page 41.

If the f_2-indicator does not function properly, remove the connection (potentiometer R159 - input 150 kc/s - low-pass filter) mentioned in annexed Fig.8, and check the wiring of the phase bridge and the discriminator for broken wires, etc.

d. Discriminator (required for fault eliminating only)

Measure the DC voltage between M9 and chassis. It should be 1.8 v and can be adjusted with R159.

Adjust the scale f_2 for 40 kc/s.

Connect the negative terminal of the DC voltmeter to M9, and the positive terminal to M12. The voltage should be 0 v ±0.05 v and can be adjusted with R113.

Set the scale f_2 to 100 kc/s. The voltage should not drop by more than approx. 0.7 v.

Adjust the scale f_2 for 0 kc/s.

The voltage should not increase by more than 0.7 v.

If these voltages are not available, or if the fault is not yet eliminated, locate it with the aid of the voltage data in the circuit diagram Rel str 35 D 328, sheet 2. Also check the forward and inverse resistances of the crystal diodes Gr17 and Gr18.

e. Phase Bridge (Ü6 - Ü7 - Md5, required for fault eliminating only)

Connect the DC voltmeter to M11, M12 (R115-R116). When the scale f_2 is rotated from 0 kc/s to 100 kc/s, the voltage variation should be as little as possible and should not exceed ±0.35 v.

If such is not the case, locate the fault with the aid of the voltage data in the circuit diagram Rel str 35 D 328, sheet 2.

f. Oscillator 2 (required for fault eliminating only)

Connect the RF diode and tube voltmeter between M14 and chassis. Alternately align C125 for maximum voltage and C121 for 0.3 v. (With this alignment the interpolation oscillator must basically function, i.e. the lamp "f_2-Indicator" must light up. If the lamp goes out during this realignment, readjust with the potentiometer R2 beside the indicator lamp).

Measure the voltage at the jack d (output f_2). It should be between 0.4 and 0.8 v.

If all voltages are available, but the device fails to work, carry out the check by reference to annexed Fig.5.

3. Checking the Frequency Scales

a. Frequency Scale f_2

Frequency alignment of the generator 2' (300 to 200 kc/s).
Connect a frequency meter (with an error of not more than $\pm 1 \times 10^{-2}$) to M10 (phase bridge and discriminator in the oscillator subassembly, see Rel str 35 D 328, sheet 2). Set scale f_2 to 0 kc/s. 300 kc/s shall be measured. Adjust the scale f_2 for 100 kc/s, the frequency at M10 should be 200 kc/s. If necessary, readjust the frequency with the trimmer capacitor C84. (This chiefly affects the lower section of the scale f_2).

Check the entire scale f_2 by reference to the following table:

Scale division	0	10	20	30 to 80	90	100 kc/s
Frequency at test point M10	300	290	280	270 to 220	210	200 kc/s

Throughout the range of scale f_2, the scale error must not exceed the tolerance of ± 300 c/s.

If there are major deviations in partial ranges, the variable capacitor must be readjusted. (Have this adjustment carried out at the factory or ask for special instructions).

b. Frequency Scale f_1 with Tuning in Spectrum Steps

Throw the function switch S4 to "Tuning in Spectrum Steps", "Pass Band 200 c/s", and the level range switch S3 to " ▼ ".
Operate the control "Tuning f_1" (megacycle scale) to 100 kc/s (within the range of the calibrating mark " ▼ "). The green lamp "Lock-in" must light up.
Adjust the control "Fine Tuning f_2" (kilocycle scale) exactly for 0 kc/s (in the range of the calibrating mark " ▼ ").
Align for maximum indication on the instrument with "Corr. f_2".
Bring the control "Tuning f_1" exactly to the 15-mc/s division. The lamp "Lock-in" must light up. If the lamp only lights up ahead of or behind the 15-mc/s scale division, i.e. the spectrum point does not coincide with the scale division for 15 mc/s and the scale calibration is hence

shifted, determine and note the sense of the deviation with increasing frequency. Now make the scale division for 15 mc/s coincide with the fiducial line. If the true spectrum point as noted above, was above (below) the associated scale division, rotate "Corr.f_1" (at the front panel) counterclockwise (clockwise) until the lamp "Lock-in" lights up. If "Corr. f_1" is not sufficient for the readjustment, effect the realignment by carefully varying C35 (see Rel ms 35 D 328 En, sheet 1).

Feed a signal with f = 15.000 mc/s into the input of the level meter. Error of this applied frequency: 1×10^{-6}.

Adjust the level range switch S3 so that the instrument of the level meter reads about full scale.

Tune for maximum indication with the control "Fine Tuning f_2". The frequency error of the scale f_1 now corresponds to the detuning of the scale f_2.

Permissible error: $\pm$600 c/s (at 15 mc/s this corresponds to the tolerance $\pm 2 \times 10^{-5}$ $\pm$300 c/s).

If the permissible frequency deviation is within $\pm$600 c/s, the rest of the scale points need not be checked, since the calibration of all frequency divisions is derived from the same 100-kc/s crystal.

If the error is excessive and occurs throughout scale f_1 with approximately the same amount, repeat the procedure "Checking Generator 10, 100 kc/s" by reference to section III.A.3.a page 21.

c. Frequency Scale f_1 without Tuning in Spectrum Steps

Operate the function switch S4 to "Continuous Tuning", "Pass Band 2 kc/s with Tuning in Spectrum Steps".

Make sure the turnkey "Reading +20 db" is not actuated (lamp must not light up) (with model "e", switch S7 to reading 0 db).

Feed in 15 mc/s, error 1×10^{-6}, and adjust exactly the middle of the lock-in range of the 15-mc/s scale point with the control "Tuning f_1" (megacycle scale).

Adjust the level range switch S3 so that the instrument reads about full scale.

Now tune for maximum indication on the instrument with the control "Fine Tuning f_2" (kc/s). Operate the function switch S4 to "Continuous Tuning, Pass Band 2 kc/s".

The indication must not change. Tolerance: 0.2 db.

If such is not the case, adjust the potentiometer R82 in the oscillator subassembly Type Rel 35 D 328 for the same indication as in operation with "Tuning in Spectrum Steps". No exact tolerances are required for "continuous scale calibration", since this position is only used for measurements of an orienting character. If the frequency of 15 mc/s cannot yet be achieved, check the DC current of the Zener diode Gr6 (see Rel str 35 D 328, sheet 1, oscillator subassembly). It should be 5.5 to 6.5 v. If this voltage is outside this range, replace the diode.

4. Checking the Meter Indication

a. At 0 db (0 dbm, 0 N, 0 Nm) and the Frequency 1 mc/s
(Checking the calibrating voltage)

Operate the function switch S4 to "Tuning in Spectrum Steps, Pass Band 2 kc/s" and the switch S2 to 75 Ω.
Operate the control "Tuning f_1" to 1 mc/s (the lamp "Lock-in" lights up).
Operate the control "Fine Tuning f_2" to 0 kc/s.
Operate the level range switch S3 to 0 db/0 dbm (0 N/0 Nm).
The key "Reading 20 db" must not be actuated (the lamp must not light up) (in the case of models "e", operate the switch S7 to "Reading 0 db/0 N").
Feed into the level meter an input of:
f = 1 mc/s, p = 0 db (0 dbm, 0 N, 0 Nm) ±0.05 db. Adjust this level exactly by reference to the calibrating level meter.
Tune the level meter for maximum indication with "Fine Tuning f_2" and then adjust exactly for the zero division with the calibrating control P (Calibrating " ▼ ").
Bring the level range switch S3 and the scales "Tuning f_1" and "Fine Tuning f_2" to " ▼ ". The lamp "Lock-in" must light up. Realign for maximum indication on the instrument with the control "Fine Tuning f_2". Do not change the position of the calibrating control P (calibrating " ▼ "). The meter must return to the zero division (red mark " ▼"). Tolerance: ±0.2 db.

If the deviation exceeds this value, readjust the indication exactly for the zero mark on the meter (red calibrating mark " ▼ ") with the potentiometer R18 in the oscillator subassembly Type Rel 35 D 328.

b. Frequency Response of the Meter Indication

Reference frequency: 1 mc/s
Feed a signal p = 0 db (0 dbm, 0 N, 0 Nm), Zi = 75 Ω.

Make the following adjustments on the level meter:

Operate switch S2 to Z = 75 Ω.

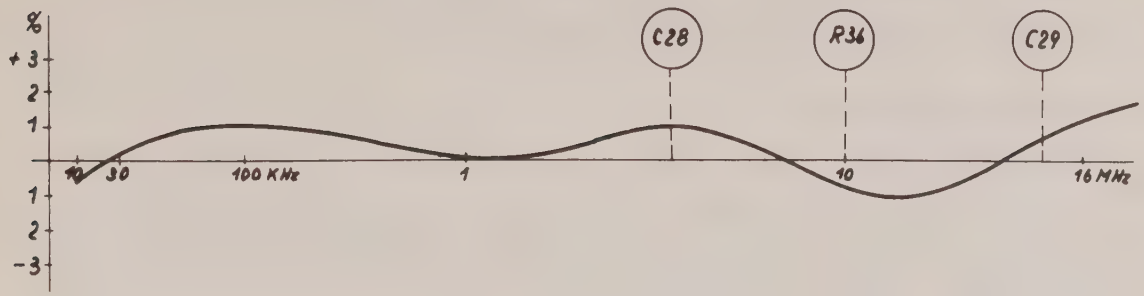
Operate the level range switch S3 to the position 0 db (0 dbm, 0 N, 0 Nm), pass band 2 kc/s with tuning in spectrum steps. Adjust the applied level so that at f = 1 mc/s, the level meter indicates approx. full scale deflection (0 db/0 dbm). Hold the applied level of the remainder of the frequencies fixed. For this purpose use an instrument that is free of frequency response in the frequency range 30 kc/s to 15 mc/s, or consider its frequency response, if any, in the measured result. Permissible frequency response of the level meter, as referred to 1 mc/s:

Between 30 kc/s and 10 mc/s: ±0.2 db
10 mc/s and 15 mc/s: ±0.5 db

In the case of greater deviations:

1. Check the tubes 1 and 2 in the measuring field Type Rel 35 D 330 (see page 35, sections III.B.5.a and b)
2. Check the tubes 4, 9, and 10 in the receiver subassembly Type Rel 35 D 340.
3. If the frequency response exceeds the specified values by a few percent only, the alignment can be made as follows:
   Set the level meter to 0 db (+10 dbm; 0 N, +1 Nm), Z = 75 Ω, pass band 2 kc/s. Connect a level oscillator, e.g. the Type Rel 3 W 518, Zi = 75 Ω, to the input of the level meter. Adjust the transmitting level at the reference frequency so that the instrument pointer of the level meter indicates zero. Monitor the transmitting level (e.g. with the Siemens RF-Multizet meter) at the second input jack of the level meter and keep it constant when aligning the frequency response. First effect the alignment at the frequencies 10 mc/s (with R36) and 16 mc/s (with C29). Then compensate for the frequency response between 6 and 10 mc/s with C28. (R36, C29, and C28 are in the measuring field Type Rel 35 D 330.) When aligning, the indication should be repeatedly checked for the 1-mc/s reference frequency and be readjusted for zero on the instrument of the level meter with the calibration control "P", if necessary.

After the alignment, the frequency response, as referred to 1 mc/s, should be about as follows:



c. Conformity of the Indications for the Pass Bands of 200 c/s and 2 kc/s

Make sure the luminous turnkey "Reading-20 db" is not actuated (lamp must not light up) or (in the case of the models "e") operate S2 to 0 db (dbm). Calibrate the level meter in the position "Pass Band 200 c/s With Tuning in Spectrum Steps". The frequency must be exactly tuned for maximum indication. Then transfer the switch to "Pass Band 2 kc/s With Tuning in Spectrum Steps" and retune the frequency for maximum indication. Do not change the position of the calibrating control "P".

If the indication for the pass band 2 kc/s fails to equal that for 200 c/s, readjust R93 (at the 3-kc/s filter, see Rel str 35 D 340) for the same indication as for "Pass Band 200 c/s".

5. Checking the Input Divider

Operate the switch S3 on the level meter first to 0 db (+10 dbm, 0 N, +1 Nm). Apply the signal via an attenuator pad, basic setting 10 db (1 N). Adjust the level so that the level meter reads 0 db (0 dbm, 0 N, 0 Nm). The calibrating control P of the level meter may be used for this purpose, but its position must not be changed afterward (take the termination of the attenuator into account).

Reference frequency 1 mc/s.

Monitor the input voltage with an instrument that is flat all the way to 15 mc/s and hold it fixed at the same value as at 1 mc/s. Check the input divider by comparison with the attenuator at 10 mc/s and 15 mc/s. The key "Reading -20 db" must not be actuated (the lamp must not light up). Operate switch S7 to 0 db (0 N) in the case of the models "e":

Permissible divider error: up to 10 mc/s $\pm$0.2 db
up to 15 mc/s $\pm$0.6 db

Note: With this measurement the error of the attenuator and the monitoring instrument must be known and considered in the measured result. Be careful in establishing the measuring setup. Use short connecting cords with correct impedance values.

6. Mains Voltage Dependence

a. Variation of the Indication

Calibrate the level meter at the nominal mains voltage. Adjust the indication exactly to the red calibrating mark " ▼ " on the meter. Do not vary the calibrating control P (" ▼ ") afterward.
Adjust the mains voltage 10 % low. Now retune for maximum indication on the level meter with the control "Fine Tuning f_2". The indication should now be the same as at the nominal mains voltage without readjusting the calibrating control P (" ▼ "), permissible deviation: $\pm$0.2 db. (Indication red calibrating mark " ▼ ")
Effect the same measurement with the mains voltage 10 % high.

When the indication is considerably affected by mains voltage variations,
1. Check the power supply unit by reference to Rel str 35 D 331,
2. Check the tubes 1 and 2 by reference to section III.B.5., page 35.
3. Check the tubes 9 and 10 in the superheterodyne unit Rel 35 D 340.

b. Variation of Frequency

Operate the function switch S4 to "Tuning in Spectrum Steps, Pass Band 200 c/s".
Feed a signal of f = 15 mc/s. Measure the frequency exactly with a frequency meter.
Adjust the indication on the level meter for a maximum.
After varying the mains voltage by +10 % (-10 %), retune the transmitting frequency for maximum indication on the level meter. Measure this necessary frequency correction.
Permissible tolerance at f = 15 mc/s: $\pm$45 c/s (corresponding to a tolerance of $\pm 1 \times 10^{-6}$ $\pm$30 c/s).

7. Selectivity

a. Pass Band 2 kc/s

Calibrate the level meter (in terms of frequency and level). Then transfer the function switch S4 to "Tuning in Spectrum Steps, Pass Band 2 kc/s" and retune for maximum indication with control "Fine Tuning f_2".

Now move the control "Fine Tuning f_2" towards lower frequencies until the meter reading decreases by 0.5 db. Note this frequency. Then increase the frequency with the control "Fine Tuning f_2" - the calibrating level is again indicated - and go on rotating in the same direction until the decrease is again 0.5 db.

The frequency spacing between the first adjustment (indication -0.5 db) and the last adjustment (indication -0.5 db) should be about 2 kc/s.

If this value is not complied with, check the 3-kc/s low-pass filter (L25, L26) in the superheterodyne unit Type Rel 35 D 340. Operate the function switch S4 to "Pass Band 2 kc/s", and turn the calibrating control "P" fully to the CW stop.

Feed a signal of f = 3 kc/s at M23 with an internal impedance of 600 Ω. For an applied level between -40 and -46 db (-4.7 N and -5.3 N), the meter should read approx. 0 db (0 N). When the frequency is varied by +1 kc/s (i.e. 2 to 4 kc/s), the level meter reading should remain constant to within 0.2 to 0.3 db (0.02 to 0.03 N).

If this cannot be achieved, check the wiring and switch S4, the latter also for good contact. For the attenuation-vs.-frequency curve of the 3-kc/s low-pass filter see page 20 of the Description, Fig.12a.

b. Bandwidth 3.1 kc/s

This measurement is made in the same way as that described under a. However, the position of the control "Fine Tuning f_2" must be varied so that below and above the indication of the calibrating level a drop of 3 db (0.35 N) is indicated. The frequency spacing between these two settings should be 3.1 kc/s to within about 200 c/s.

c. Stop Band Loss at f_m ±4 kc/s

Feed a signal f = 100 kc/s, p = 0 db/0 dbm (0 N, 0 Nm)

Level meter: operate the function switch S4 to the position "Tuning in Spectrum Steps, Pass Band 2 kc/s" and tune for 100 kc/s.

Detune the transmitting frequency by ±4 kc/s. Do not readjust the frequency setting of the level meter, but rotate the level range switch S3 counterclockwise until the meter indicates a well readable level.

The stop band loss should be about 60 db (7 N) (corresponds to a level indication of -60 db/-7 N).

If these values are not complied with, check:

1. 50-kc/s Band-Pass Filter Type Rel 35 D 419 (Superheterodyne unit Type Rel 35 D 340)

   Operate switch S4 to "Pass Band 2 kc/s" and the level range switch S3 to the most sensitive position (CW stop), fully opening the calibrating control "P" (CW stop). Feed a signal of f = 50.0 kc/s at M17 via an attenuator Z = 75 Ω with termination into 75 Ω.

   At an applied level of -67 db ±3 db (-7.9 N ±0.3 N) the instrument should read about 0 db (0 N).

   When the frequency is varied by ±800 c/s, the indication may change by ≦ 0.5 db (0.05 N). At 50.000 kc/s ±1.55 kc/s, the decrease should be 3 ±1 db (0.35 ±0.1 N), as referred to 50 kc/s.

   If values other than these are measured, do not under any circumstances change the positions of the coil cores, but order a spare subassembly from the supplier. For repair at the factory the band-pass filter alone can be forwarded.

   For the attenuation-vs.-frequency curve of the 50-kc/s band-pass filter see page 20 of the Description, Fig.11.

2. 1.5-mc/s Band-Pass Filter Type Rel 35 D 421

   If the indication varies by 1 to 2 % as a result of shocks, the fault may be due to this band-pass filter (poor soldering connection, damaged coil cores). This can be checked by tapping on the filter. First check the wiring of the subassembly. If there is no other fault present, check the band-pass filter by throwing switch S4 on the level meter to "Pass Band 2 kc/s" and the level range switch S3 to the most sensitive position (CW stop). Open the calibrating control "P" fully.

   Via an attenuator of Z = 75 Ω with 75-Ω termination feed a signal of f = 1.5 mc/s with a level of -80 db (-9.6 N) between the soldering lug 3 of Ü6 and chassis. Vary the frequency of the applied signal slightly and adjust it so that the instrument shows a maximum deflection. For an applied level of -82 db (-9.7 N) the meter should read 0 db ±3 db (0 N ±0.35 N). Tap gently on the coils L12, L13, L14, L15 with a light object, e.g. a pencil. The indication must not change.

   If this tapping leads to greater level variations (approx. 3 db/0.35 N or more), disassemble the 1.5-mc/s band-pass filter and forward it to the factory for repair or request a new band-pass filter from the factory. However, do not under any circumstances change the positions of coil cores. For the attenuation-vs.-frequency curve of the 1.5-mc/s band-pass filter see page 20 of the Description, Fig.10.

d. Pass Band 200 c/s

The measurement is made as that described under a., but the function switch S4 is set at "Tuning in Spectrum Steps, Pass Band 200 c/s". The frequency spacing between the indicating points of -0.5 db (-0.05 N) below and above the correct indication should be approx. 200 c/s.

e. Stop Band Loss at f_m +1 kc/s

Measurement as desdribed under c., but leave the function switch at "Pass Band 200 c/s".
When the transmitting frequency is detuned by $\pm$1 kc/s, the stop band loss should be about 35 db (4 N).

f. Stop Band Loss at f_m +2 kc/s

Measurement as described under e.
When the transmitting frequency is detuned by $\pm$2 kc/s, the stop band loss should be about 52 db (6 N).
If these values are not complied with, check:
the 3-kc/s band-pass filter (L22, L23, L24) in the superheterodyne unit Type Rel 35 D 340. Check first the wiring of L22, L23, L24 and the contact closure of switch S4.
If no fault can be found, operate the function switch S4 to "Pass Band 200 c/s" and the calibrating control "P" to the CW stop. Feed a signal of exactly f = 50 kc/s at M20 via an attenuator of 75 Ω with termination into 75 Ω. For an applied level of -39 db to -42 db (-4.5 N to -4.7 N) the instrument of the level meter should read about 0 db (0 N). When the frequency of 50.000 kc/s is varied by $\pm$100 c/s, the indication should vary by $\leq$ 0.5 db (0.06 N). If this requirement is not met, do not under any circumstances vary the positions of the coil cores, but disassemble the device and forward it for repair to the factory. If necessary, order a spare band-pass filter. For the attenuation-vs.-frequency curve of the 3-kc/s band-pass filter see page 20, Fig.12b of the Description.

8. Image-Frequency Rejection

a. for $f_m + 2 f_{z1}$

Calibrate the level meter before starting the measurement. Then make the following settings on the level meter:
Operate the function switch S4 to "Tuning in Spectrum Steps, Pass Band 2 kc/s", and the control "Tuning f_1" to 1 mc/s.

Operate the control "Fine Tuning f_2" to 0 kc/s.
(These settings on the level meter are retained for further measurements of the image-frequency rejection).
Feed a signal f = 43 mc/s, p = 0 db/0 dbm, 0 N, 0 Nm, Z = 75 Ω.
Rotate the level range switch S3 on the level meter counterclockwise until the level meter shows a well readable deflection. The image-frequency rejection required for $f_m + 2 f_{z1}$ is about 60 db (7 N).

If the specified values are not complied with, the fault will be presumably in the 17-mc/s low-pass filter Type Rel 25 D 420. After checking the wiring apply to the input of the low-pass filter (L1 soldering lug 5, see Rel str 35 D 340 En) a signal of f = 17 mc/s, n = -72 db (-8.6 N). If the instrument fails to indicate 0 db ±3 db (0 N ±0.3 N), apply the signal to the output of the 17-mc/s low-pass filter (L4, soldering lug 1) as specified in Rel str 35 D 340. If the indication is then 0 db (0 N), the fault is due to the low-pass filter. Otherwise the modulator 1 must be checked. Check the crystal diodes for their forward and inverse resitances. If the fault is in the 17-mc/s low-pass filter, do not vary the coil cores, but order a new low-pass filter from the factory for replacing the faulty one.

b. <u>for $f_m + 2 f_{z2}$</u>

Settings on the level meter as described under a.
Apply the signal as described in section a, but with f = 4 mc/s.
Required image-frequency rejection: Approx. 74 db (8.5 N).

If this value is not complied with, the circuit of the 21-mc/s band-pass filter (L7 to L10) in the superheterodyne unit Type Rel 35 D 340 must be checked.
If no fault is located, apply a signal of f = 21 mc/s, n = -100 db (-11.5 N) to the input of the filter (soldering lug 2 of the transformer Ü2, see Rel str 35 D 340 En). If now the instrument fails to read 0 db ±3 db (0 N ±0.3 N), check first the 21-mc/s amplifier (and apply the signal to C35 according to Rel str 35 D 340). If the indication of 0 db (0 N) cannot be achieved even now, check the modulator 2 (by applying the signal to the junction C43/L11 and checking the crystal diodes for their forward and inverse resistances). If the fault is due to the 21-mc/s band-pass filter, do not vary the positions of the coil cores, but replace the band-pass filter as a whole. For the attenuation- vs.-frequency curve of the 21-mc/s band-pass filter see page 20, Fig.9 of the Description.

c. for $f_m + 2 f_{z3}$

Apply a signal f = 1.1 mc/s.

Image-frequency rejection required: approx. 74 db (8.5 N).

If this value cannot be achieved, check first the wiring of the 1.5-mc/s band-pass filter. Check this band-pass filter by reference to section III.A.7.c.2, page 28.

d. for $f_m + 2 f_{z4}$

Apply a signal f = 1.006 mc/s.

Image-frequency rejection: approx. 60 db (6.9 N).

If this value cannot be achieved, check the 50-kc/s band-pass filter by reference to section III.A.7.c.1, page 28.

9. IF Breakthrough Selectivity

Apply in succession the following signals:

p = 0 db/0 dbm
Z = 75 Ω

a. IF1 = 21 mc/s
b. IF2 = 1.5 mc/s
c. IF3 = 50 kc/s
d. IF4 = 3 kc/s

Adjust the level meter for Z = 75 Ω. The frequency setting is inconsequential, but avoid setting one of the intermediate frequencies specified under a. to d. Rotate the level range switch S3 counterclockwise until a corresponding reading is available. The indicated level corresponds to the IF breakthrough selectivity, which should be about 80 db (9.2 N).

10. Residual Distortion

The residual distortion can only be checked with an oscillator of very low distortion. Besides, the oscillator harmonics must be eliminated by a low-pass filter. The oscillator harmonics should be $\geq$ 100 db down, or else the measured result would be in error. Feed the low-distortion voltage with a transmitting level of -40 db (-30 dbm, -5 N, -4 Nm) to the input of the level meter.

Actuate the key T_1 in the case of level meters of the model Rel 3 D 335d, and the switch S7 in the case of models Rel 3 D 335e. Now measure the level at the fundamental frequency. Tune the level meter then first for double (a_{k2}) and then for triple (a_{k3}) the level oscillator frequency and measure the levels of these harmonics. The difference between the indication at the fundamental and that at the harmonics (a_{k2} and a_{k3}) should be $\geq$ 65 db (7N).

If this value is not achieved, check the harmonic content of the level oscillator voltage as a first step. If it is sufficiently low, but the specified values are not yet achieved, check the tubes 1 and 2 in the measuring field Type Rel 35 D 330 by reference to section III.B.5.a and 5.b, page 35. If the residual distortion is markedly too high (i.e. by 10 db (1 N) or more), check modulator 1 in the superheterodyne unit Type Rel 35 D 340 (resistors R11, R12, R13, R14 and the forward and inverse resistances of the crystal diodes Gr1, 2, 3, 4). The forward resistances of all four crystal diodes should agree to about within 10 %.

Note: Do not solder on the rectifiers when checking modulator 1, but split at the resistor junctions R11/R12 and R13/R14. When soldering, note the information given in section I, pages 1 and 2.

If a crystal diode has failed, the whole quad of crystal diodes must be replaced. Moreover, the balanced condition of modulator 1 must be realigned. Request special instrutions from the factory in such a case, or in a case where the fault cannot be detected, although the device is otherwise in order.

If all components mentioned are in order, the residual distortion can be reduced by cautiously varying C23 (see Rel str 35 D 340 En).

B. Further Information

1. Checking the Superheterodyne Unit Type Rel 35 D 340 by Reference to Annexed Fig.6

Note: The meter must indicate 0 db ±3 db (0 N ±0.3 N) when the levels specified in the annexed Fig.6 are applied. For the location of the components see also Fig.8 in the parts list.

2. Oscillator Voltages in the Superheterodyne Unit

a. At the Inputs f_1 and f_2

Set the control "Tuning f_1" to 0.5 mc/s, and f_2 to 50 kc/s. At jack "d" (input f_1), the AC voltage (of 21.6 mc/s) should be about 2.5 to 3.0 v, and at jack "c" (input f_2; 19.55 mc/s) approx. 0.4 to 0.9 v.

If these voltages are not present, disconnect the lines (cap nut) coming from the jacks "c" and "d", screw the plug in position, and check the soldering points of the inner conductor on the plug. If the connecting cords are in order, but the voltage is not available despite this, the fault is due to the oscillator subassembly Type Rel 35 D 328 or preamplifier (measuring field Type Rel 35 D 330). If such is the case, check by reference to the annexed Figs. 7 and 8 and localize the fault on the basis of the information given in Rel str 35 D 330.

b. At Oscillator 1.45 mc/s (Tube Section 6^I)

The AC voltage (of 1.45 mc/s) at M18-M19 (transformer Ü7 between the soldering lugs 4 and 6) should be between 1.45 and 3.0 v. Adjust this voltage for a maximum with C61.

If the maximum deviates markedly from the specified values, tube 6 must be checked. If necessary, locate the faulty component by reference to the circuit diagram Rel str 35 D 340 and the voltage data in it. If the tube is in order, but the voltage is too low or the generator fails to work, the oscillating capacity of the generator can be enhanced by increasing the value of resistor R53 to between 800 and 1000 Ω. Subsequently check the frequency and readjust it to 1.45 mc/s ±20 c/s with C65. (Connect to M18/M19 the frequency measuring device, error $\pm 1 \times 10^{-6}$.)

c. At Oscillator 47 kc/s (Tube Section 6^{II})

The (47-kc/s) AC voltage between M21 and M22 (soldering lug 6 of the transformer Ü9 and soldering lug 6 of transformer Ü10) should be about 0.8 v to 1.2 v.

If this voltage is not present, check tube 6 and subsequently locate the fault with the aid of the data in the circuit diagram Rel str 35 D 340 En. When the voltage or the level meter indication varies by 1 to 2 % as a result of shocks, the fault may be due to the 47-kc/s crystal (Kr2) (this can be found out by gently tapping on the crystal).

3. Transfer to "Reading -20 db (-2 N)"

If the key "Reading -20 db/-2 N" fails to transfer properly, clean its contacts first (in the power supply unit Type Rel 35 D 331). Check the wiring and the resistors R11, R12, R13, R14 at the key. Minor transfer errors can be eliminated by alignment with R14.

In the case of the level meter models "e", switch S7 and the resistors R11 to R14 as well as relay B must be checked by reference to section III.B.6.c.

4. Realignment of the Balance of the Modulator 2

This realignment is necessary, e.g. when the parasitic deflection becomes too high or if there is an excessive frequency response in the range of the control "Tuning f_2".

Apply to the input of the level meter the following signal:	Level -10 db (0 dbm; -1 N; 0 Nm), Zi = 75 Ω, frequency 1.75 mc/s
Set on the level meter:	-70 db (-60 dbm; -8 N; -7 Nm) frequency 1.0 mc/s; pass band 2 kc/s with tuning in spectrum steps.

Effect a small variation of the oscillator frequency at 1.75 mc/s to maximize the level meter reading.

Minimize this reading with C44 in the superheterodyne unit Type Rel 35 D 340. The instrument pointer should be below the 0-db (0-N) mark. If this cannot be achieved or if the frequency response continues to be markedly dependent (5 to 10 %) on the setting of the control "Tuning f_2", check first the modulator 2 and R21 to R24.

Note: When checking modulator 2, do not solder on the rectifiers, but split at the resistor junctions R21/R22 and R23/24. The crystal diodes are highly temperature-sensitive. If a crystal diode has failed, the entire quad must be replaced and the balance alignment repeated.

5. Replacing a Tube in the Preamplifier (Measuring Field Type Rel 35 D 330)

The decreasing emission of the tubes 1 and 2 in the measuring field increases the dependence of the indication on the mains voltage and the frequency, as well as the residual distortion.
With properly performing tubes, the following DC voltages must be measured with a high-impedance instrument $\geq$ 50.000 Ω/v.

a. With Nominal Value of the Mains Voltage

Between M28 and chassis: 27 $\pm$0.1 v (adjustable with the potentiometer R13 in the measuring field)

Between R18 and chassis: 26.5 $\pm$1 v

b. When the Mains Voltage is 10 % Low

a. Between the wiper (center tap) of the potentiometer R13 (negative terminal) and R19 (cathode of tube section 1^{II}) $E_{gk} \geq 0.2$ v.

b. Between R25/26 (negative terminal) and the cathode of tube section 1^{I} $E_{gk} \geq 0.2$ v. If these values are not achieved, tube 1 must be replaced.

c. Between the wiper (center tap) of the potentiometer R13 (negative terminal) and M28: $E_{gk} \geq 0.2$ v.
If this value is not achieved, tube 2 must be replaced.

6. Checking the Relays

See the abridged circuit diagram of annexed Fig.9.

With each alternate step of the level range switch S3 in the measuring field, another capacitive attenuator is connected into circuit with a 20-db increase in each case. In the intermediate positions relay A switches into circuit the resistive 10-db (1-N) attenuator (R1/R3) at the input of the superheterodyne unit. The 10-db (1-N) attenuator (R75/R76) ahead of the input of the amplifier II (50 kc/s) disconnects relay B in the most sensitive position S2 in the case of the models Rel 3 D 335d..., and in the positions 2 and 4 of switch S7 in that of the models Rel 3 D 335e..

The lamp "Lock-in" is controlled by relay C. The transfers for automatic tuning in spectrum steps from the oscillator are effected by the relays D (Synchr. f_2) and E (Synchr. f_1). The operating voltage is applied via the level range switch S3 III and the rectifiers Gr3 to Gr5 to the relays A,

f_1, f_2 and f_3. The windings of the relays D and E are only connected to ground when the connecting cords "Synchr. f_1" and "Synchr. f_2" to the level oscillator are plugged in. The relay F controls the lamp "f_2 Indicator".

Interrelation of Switches and Relays

Switch position	Relays (x denotes: relay is energized) A	B	C	D	E
S5 Level Range of Models: 1.. dB / 2.. dBm / 3.. Nm / 4.. N					
▼ ▼ ▼ ▼	x				
+2 - - +3					
+1 +20 +30 +2	x				
0 +10 +20 +1					
-1 0 +10 0	x				
-2 -10 0 -1					
-3 -20 -10 -2	x				
-4 -30 -20 -3					
-5 -40 -30 -4	x				
-6 -50 -40 -5					
-7 -60 -50 -6	x				
-8 -70- -60 -7					
-9 -80 -70 -8	x				

x Only with the models "d"

S4 Pass band width				
Continuous Tuning { 200 c/s / 2 kc/s				
Tuning in Spectrum Steps { 2 kc/s / 200 c/s		x x		
Switches at jacks "Synchr. f_1"				x
"Synchr. f_2"			x	

Only with the models "e"

S7 Reading of model: e1.. N	e2.. db	e3.. dbm	e4.. Nm		
0	0	0	0		
-1	-10	-10	-1	x	
-2	-20	-20	-2		
-3	-30	-30	-3	x	

a. Checking the Circuit

1. Find out whether the voltage of +30 to 25 v is available at switch S3 in the measuring field via C56.

2. Check the wiring of switch S3, deck III.

3. Check the crystal diode circuits by reference to the following table:

With Devices Calibrated in	Level Range Switch S3 in Position	Voltage at	With Incorrect Voltage, Check
db/dbm		C59 +20 to 25 v	Gr3
	-60 db/-50 dbm	C60 +20 to 25 v	Gr4
		C57 0 v	Gr5
	-70 db/-60 dbm	C59 0 v	Gr4
	-80 db/-70 dbm	C60 +20 to 25 v	Gr5
	▼	C60 0 v	Gr3
N/Nm	-9 N/-8 Nm	C60 +20 to 25 v	Gr5
	+1 N/0 Nm	C59 +20 to 25 v	Gr3
		C60 +20 to 25 v	Gr4
	+2 N/+3 Nm	C59 0 v	Gr4
	▼	C57 0 v	Gr5
		C 60 0 v	Gr3

If the specified voltages are not measured, the respective capacitor and the continuing wire must first be checked for chassis connection. Subsequently check the crystal diode specified in the table for its forward and inverse resistances and replace it, if necessary.

b. Relay A

Check the resistors and the wiring of the divider R1/R3 in the superheterodyne unit Type Rel 35 D 340.
Operate the level range switch S3 to " ▼ ". Relay A is energized and a voltage of +20 v is at C16 and the operating winding of the relay.
R3 is connected to chassis via the relay contact.
Rotate the level range switch S3 back by one (in the case of N/Nm calibration) or two steps (in the case of db/dbm calibration). The relay restores and the voltage across C16 becomes zero. The chassis connection for R3 is interrupted and the connection to R1 established. If such is not the case, clean the contacts of the relay. When the operating voltage is connected or disconnected, but the armature of the relay fails to operate, relay A must be replaced.

c. Relay B in Models Rel 3 D 335d..

Check the resistors and the wiring of the divider R75/R76 in the superheterodyne unit Type Rel 35 D 340.
Set the level range switch S3 to the most sensitive position. The relay operates. The operating voltage of +20 v is available at the soldering lug of the relay and the divider R75/R76 is deenergized (the contacts 9 and 10 are connected). Rotate the level range switch back by one step. The 20-v supply is disconnected. The divider R75/R76 is connected in circuit (contacts 9 and 8 are interconnected). The transfer click of the relay can be heard.

If the operating voltage at the soldering lug 1 is correctly connected and disconnected, but the divider is not switched, measure first the DC resistance of the relay winding (between the soldering lug 4 and 1). Nominal value: 1250 Ω ±20 %. Replace the relay, if necessary. If the value of the resistance is found to be correct, and the relay operates or drops out without switching the divider, the fault is likely to be due to poor contact. In such case, resoldering from the contact b^{I} to the unassigned contact b^{II} can be made as a makeshift (8 to 5, 9 to 6, and 10 to 7). If even now the voltage divider is not switched, the relay must be replaced.

d. Relay B in Model Rel 3 D 335e..

Check the resistors and the wiring of the divider R75/R76 in the superheterodyne unit Type Rel 35 D 340.

In the positions "Reading -10 db (-1 N)" and "Reading -30 db (-3 N)" of switch S7 relay B operates. The operating voltage of +20 v is available at the relay winding and the divider R75/R76 is switched out of circuit. (Contacts 9 and 10 are interconnected.)

Rotate switch S7 successively back by 1 step. The relay drops out (0 v at the relay winding). The divider R75/R76 is inserted in circuit (the contacts 9 and 8 are connected). The transfer click of the relay can be heard.

If the operating voltage at the soldering lug 1 is correctly connected and disconnected, but the divider is not switched, measure the DC resistance of the relay winding (between the soldering lug 4 and 1). Nominal value: 1250 Ω ±20 %. Replace the relay, if necessary. If the value of the resistance is found to be correct, but the relay operates or drops out without switching the divider, the fault is likely to be due to poor contact. In

such case resoldering from contact b^{I} to the unassigned contact b^{II} can be used as a makeshift (8 to 5, 9 to 6, and 10 to 7). If even now no transfer is effected, the relay must be replaced.

e. Relay C

This relay is controlled by the anode current of tube section 16^{II} in the oscillator subassembly Type Rel 35 D 328. In the case of "Continuous Tuning" switch S4 interrupts the anode voltage for tube section 16^{II} and brings into circuit a substitution load with respect to chassis (R26). This causes the relay C to drop out and contact c^{II} (9-10) to open so that the lamp "Lock-in" goes out.

In the case of operation with "Tuning in Spectrum Steps" the anode voltage $+A_2$ (100 v) is applied via S4, R92, winding of relay C and R95 to the anode II of the tube 16. By adjusting the control "Tuning f_1" to a spectrum frequency (n x 100 kc/s) this tube is made to conduct. The anode voltage at the tube drops from 100 v to about 55 v and relay C operates. The contacts c^{II} (9-10) close and the connection C170 (6.3 v) - lock-in lamp - C38 - R48 - chassis is established (via the contacts 5 and 6 of relay E), i.e. the lock-in lamp lights up, thereby indicating the locked condition.

Outside the lock-in range, however, an AC voltage (of f < 50 kc/s) is applied to the grid and blocks the tube via the rectifier assembly Gr11, C76, R96, etc.

As a check operate the function switch S4 to "Continuous Tuning" and interconnect the contacts 9 and 10 on relay C. The lamp "Lock-in" must light up. If such is not the case, check: the lock-in lamp Sl 3, the voltage of 6.3 v at C170, the wiring of C170 via the lock-in lamp and relay E, and the contacts 5/6 with respect to chassis. If there is an interruption at relay E, it must be checked.

Now interrupt the connection between contact 9 and 10 on relay C. The lock-in lamp must go out. If it does not, there is a short-circuit between the contacts 9 and 10 of relay C. In this case a transfer from the contacts c^{II} to the unassigned contacts c^{I} can be used as a makeshift (connection 10 to 7, and 9 to 6). If even then the lamp fails to go out, relay C must be replaced.

Operate the function switch S4 to "Tuning in Spectrum Steps". Rotate the control "Tuning f_1" slowly from one spectrum point to the next one. Now the

anode voltage at tube section 16^{II} must vary from 100 v (outside a spectrum point) to approx. +55 v (in the spectrum point). The relay must drop out at +100 v and operate at +55 v in each separate case (this click can be distinctly heard).

If no anode voltage is available, the path C18 - switch S4 - relay C - anode is interrupted (DC resistance of the relay winding equals 1250 Ω ±20 % between the terminals 4 and 1).

If the voltage fails to vary from 100 to 55 v, locate the fault in the lock-in indication amplifier or the spectrum oscillator by reference to annexed Fig. 7. If all described functions are in order but the relay fails to switch in spite of this, it must be replaced.

f. Relay D

In the case of "Synchr. f_2" relay D disconnects the voltage of generator 2' (300 to 200 kc/s) and applies the voltage from generator 2' of the level oscillator instead.

The operating voltage (+20 v) for the relay is applied to the winding of relay D via the switch S3, deck III, in the measuring field. By plugging the connecting cord for synchronization of f_2 between level oscillator and level meter, the relay winding is connected to chassis via the coil L11 in the level oscillator. The relay operates. The anode voltage for tube section 20^{I} is disconnected by the contacts d^{II} (i.e. the generator 2' of the level meter fails). Contact d^{I} simultaneously disconnects tube section 20^{I} from generator 2' of the level meter and connects it to generator 2' of the level oscillator.

Operate the level range switch S3 to " ▼ " as a check. The anode voltage for tube section 20^{I} should be applied to the contacts 8 and 9 of relay D with +100 v. All other contacts carry no voltage. Rotate the level range switch S3 away from the position " ▼ " and connect the input "Synchr. f_2" to chassis. The relay must operate (this click can be clearly heard).

Now the contact spring 9 must no longer carry anode voltage. The operating winding (terminal 4), however, carries a voltage of 20 v. The contacts 6/7 are interconnected. If there is a fault, check first all lines to relay D. Is there a chassis connection at the input "Synchr. f_2" and the relay terminals 1 and 7? Check the DC resistance of the relay winding between the terminals 1 and 4 (1250 Ω ±20 %). If the circuit is in order, the relay must be replaced.

g. Relay E

In the case of "Synchr. f_1" relay E in the measuring field Type Rel 35 D 330 disconnects the spectrum oscillator 21.1 to 38.1 mc/s of the level meter from the input of the carrier amplifier and connects it via the line "Synchr. f_1" to the spectrum oscillator of the level oscillator. At the same time a substitution load for the disconnected spectrum oscillator is introduced by the resistor R43 via e^{I} and the chassis connection to the lock-in lamp of the level meter is interrupted. The relay receives operating voltage via switch S3. By plugging the cord "Synchronization f_1" between level oscillator and level meter, the chassis connection in the level oscillator is established via the coil L4. The relay operates.

Operate the level range switch S3 to " ▼ " for a check. The terminals 4 and 1 carry no voltage. Voltage at terminal 7: +100 v; the terminals 5, 6, 8, and 9 are at chassis potential. The DC resistance of the winding should be 1250 Ω ±20 %.

Rotate the level range switch away from the position " ▼ " and connect the input "Synchr. f_1" to chassis. The relay must operate, voltage at terminal 4: 20 v, the terminals 1 and 7 carry no voltage. The connections of the contact 8-9 and 5-6 are interrupted. The contacts 10, 9, 7, 6 are connected to chassis.

If there is a fault, check first the leads to the relay contacts. If no fault is detected or if the DC resistance of the winding is found to be incorrect, the relay must be replaced.

h. Relay F

Relay F is controlled by the anode current of tube section 21^{II}. If the regulating circuit of the interpolation oscillator is working properly, i.e. the oscillator is locked in and no regulating oscillations occur, the tube section 21^{II} carries current. The anode voltage at tube section 21^{II} (terminal 4 of relay F) drops from 100 v to about 75 v and relay F operates. The contacts f^{II} (9-10) close. Thus, voltage is applied to the lamp SL5 and the proper functioning of the interpolation oscillator is indicated. When the interpolation oscillator does not work, AC voltage appears at the grid of tube section 21^{I}. The section I of the tube is blocked via the rectifier assembly Gr1/Gr2, no anode current flows, relay F does not operate, and the lamp SL5 does not light up.

Check first the setting of the potentiometer R2 (beside the indicator lamp). If this does not eliminate the fault, check the anode voltage at tube 21 and the AC voltage of 6.3 v at relay F, the contacts 9 and 10 and the lamp SL5. Replace lamp SL5, if necessary. If the operating voltage at the soldering lug 1 of relay F is approx. 75 v, but this relay fails to switch, or the soldering lug 10 of relay F fails to receive voltage (6.3 v), the DC resistance of the relay winding (between the soldering lugs 4 and 1) must be measured. Its nominal value is 1250 Ω ±20 %. Replace the relay, if necessary. If the resistance value is found to be correct and the relay operates, but the 6.3-v supply is not available at the soldering lug 10, the fault will be due to poor contact. In this case resoldering from the contacts f^{II} to f^{I} (9 to 6, 10 to 7) can be used as a makeshift measure.

8. Replacing the Scale Films

If a film of frequency scale f_1 or f_2 is no longer correctly transported, i.e. if it moves in jerks or if it jams when the drive is rotated, the perforation of the film will probably be damaged. New films can be ordered from the factory if the exact type designation and the serial number of the device are specified. Replacing the film is not difficult, it requires careful working, however.

Removing the Film

Unscrew all rotary controls and the panel meter, then loosen the fastening screws of the front panel and lift the latter off. Reapply the rotary controls for "Tuning f_1 and f_2", the level range switch S3, and the function switch S4, mount the panel meter and connect it. The further disassembly is based on the information in annexed Fig. 10.

Mounting the New Film (stick to the sequence)
Film f_1 (mc/s)

The film is supplied in a tightly rolled-up form (the lettering for the low frequencies must be readable from the outside).

First of all, the dust must be carefully removed from the film guide with a soft brush. Then

a. Insert the rolled-up film with care vertically into the right-hand holding spring. Caution. - This spring must not be distorted, or else the film will no longer be transported.

b. Feed the film carefully to the left into the film guide until the mark "▼" of the film matches exactly the fiducial line on the scale window.

c. Make the following adjustments on the level meter (do not insert the film box as yet): Operate the control "Fine Tuning f_2" to 0 kc/s " ▼ ", and switch S3 to " ▼ " (CW stop), and the function switch S4 to "Pass Band 200 c/s with Tuning in Spectrum Steps" (CW stop).

d. Swing up the pointer of the dismounted film scale f_1 and bring the pointer of the general scale to 0 mc/s with the rotary control "Tuning f_1". The lamp "Lock-in" must light up. There is a considerable deflection on the instrument.

e. Advance the drive f_1 clockwise (0.1 mc/s) by one spectrum point. The lamp "Lock-in" must light up and the calibrating voltage indicated. Adjust the control "Fine Tuning f_2" for maximum indication on the instrument. It must then be possible to adjust the red calibrating mark on the instrument with the aid of the calibrating control "P".

f. Operate the function switch S4 to "Continuous Tuning", "Pass Band 200 c/s" (CCW stop).

g. Readjust the calibrating voltage carefully for maximum indication and do not change this adjustment afterward.

h. Swing down the pointer and insert the film box carefully, without exerting any pressure. The perforation of the film must fall into mesh with the toothed wheel without pressure.

i. Insert the fastening screws (annexed Fig.10) and swing up the pointer.

k. Check whether the scale calibration is correct, i.e. whether the film is correctly inserted. In so doing rotate the scale carefully. The drive must not jam. If during the rotation a somewhat louder noise can be heard or if the film fails to run smoothly and passes by the scale window in undulations, the perforation of the film has not correctly engaged the toothed wheel. Under no circumstances advance the film any further, but check the insertion of the film once more.

If the transport of the film is correct, reapply the front panel, the instrument, and the rotary controls.

Film f_2 (kc/s)

The film is supplied in tightly rolled-up form (the lettering for the low frequencies must be readable from the outside).

First of all the dust must be removed from the film guide with a soft brush, then:

a. Insert the rolled-up film with care vertically into the right-hand holding spring. Caution.- The holding spring must not be distorted, or else the film will no longer transport.

b. Feed the film with care to the left into the film guide until the 0-kc/s calibrating mark matches the fiducial line on the scale window.

c. Make the following adjustments on the level meter:
Operate the level range switch S3 to " ▼ " (CW stop), the function switch S4 to "Pass Band 200 c/s with Tuning in Spectrum Steps" (CW stop).
Operate the control "Tuning f_1" to " ▼ ".
The lamp "Lock-in" must light up.

d. Swing up the pointer of the disassembled film scale f_2 (do not insert the film box as yet) and set 0 kc/s (" ▼ ") with the rotary control "Fine Tuning f_2" so that the meter reads the calibrating voltage. Tune the control "Fine Tuning f_2" for maximum indication and do not change this adjustment afterward.

e. Swing down the pointer again and insert the film box slowly without exerting any pressure. The perforation of the film must fall into mesh with the toothed wheel without pressure.

f. Insert the fastening screws (annexed Fig. 10) and swing up the pointer.

g. Check whether the scale calibration is correct, i.e. whether the film has been correctly inserted. Then rotate the film carefully. The drive must not jam. If during the rotation a somewhat stronger noise can be heard, i.e. when the film is transported in jerks and not smoothly and passes by the scale window in undulations, the perforation of the film has obviously failed to engage the toothed wheel correctly. Do not advance the film now any further, but recheck the insertion of the film.

h. If the film is correctly transported, reapply the front panel, the instrument, and the rotary controls.

9. Parasitic Deflection at 300 and 600 kc/s

In some devices a strikingly great parasitic deflection may occur when f_1 is tuned for 300 and 600 kc/s ("Tuning f_2" at 0 kc/s), and if the input is open and switch S2 (Z/Ω) is at ∞. In such cases the resistors R75/R76 in the superheterodyne unit receive interfering voltages due to their position (shown dashed in the annexed Fig. 4). In addition, there are two unfavorable chassis connections in the oscillator subassembly (Fig. 5). By reconnecting them in accordance with the Figs. 4 and 5, such parasitic deflections can be positively eliminated.

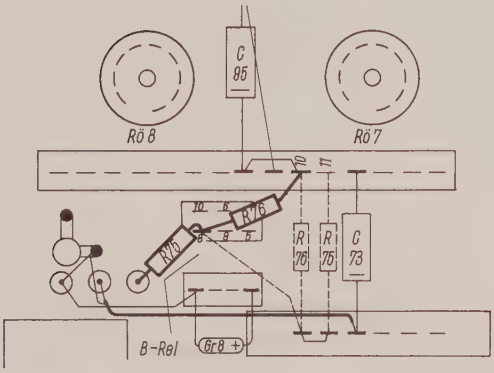


Fig. 4 SECTION OF Rel ms 35 D 340

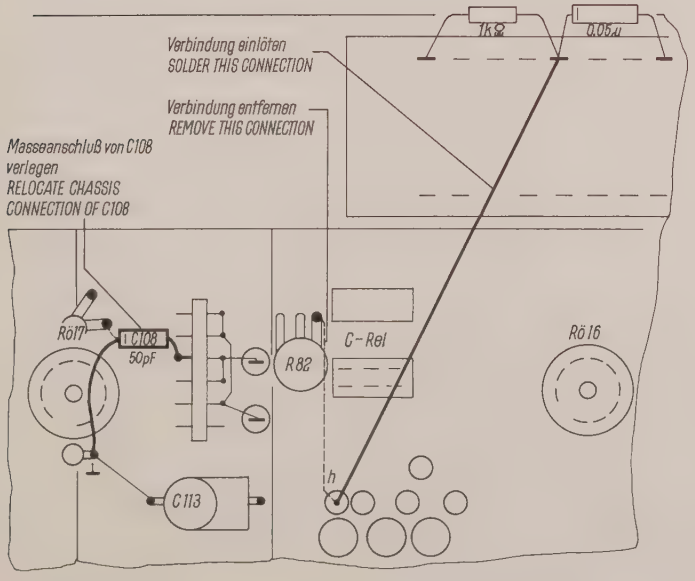


Fig. 5 SECTION OF Rel ms 35 D 328

IV. ANNEXED FIGURES

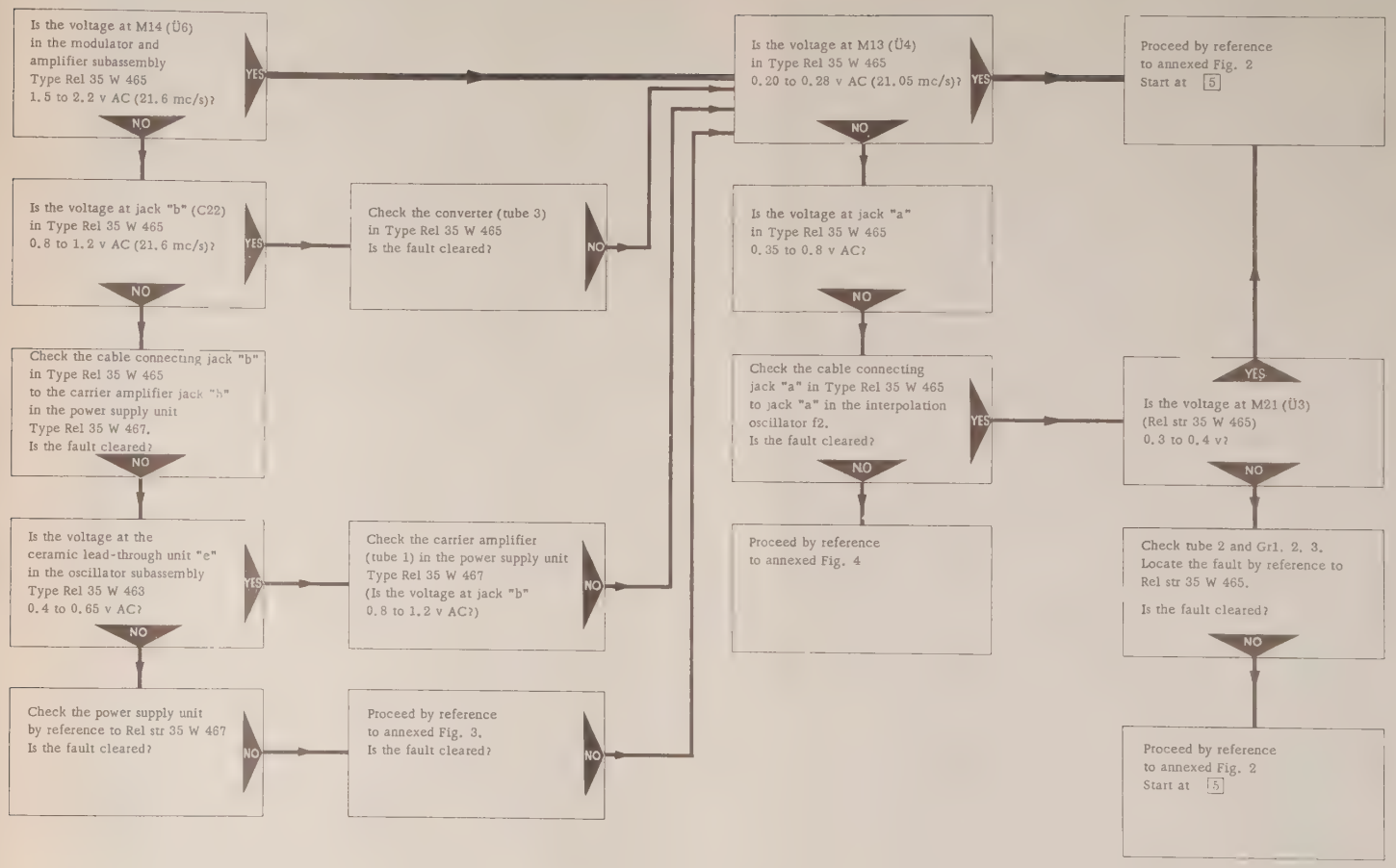
This part combines the following:

	Annexed Figure
Fault Locating Plans:	
Level Oscillator, Locating the Faulted Subassembly	1
Level Oscillator, Checking the Modulator and Amplifier Subassembly	2
Level Oscillator, Checking the Spectrum Oscillator f_1	3
Level Oscillator, Checking the Interpolation Oscillator f_2	4
Level Meter, Locating the Faulted Subassembly	5
Level Meter, Checking the Superheterodyne Unit	6
Level Meter, Checking the Spectrum Oscillator f_1	7
Level Meter, Checking the Interpolation Oscillator f_2	8
Level Meter, Abridged Circuit Diagram for the Relay Functions	9
Scale Drives:	
Taking Out a Scale Film	10
Adjusting the Fine Drive f_1	11

SIEMENS
WELTVERKEHRS
TECHNIK

Before starting with the check,
operate switch S4 to "Continuous Tuning"
scale f1 to 0.5 mc/s
scale f2 to 50 kc/s

For the measuring points "M.." see Rel str and ms 35 W 465


Is the voltage at M14 (Ü6) in the modulator and amplifier subassembly Type Rel 35 W 465 1.5 to 2.2 v AC (21.6 mc/s)?
YES
NO
Is the voltage at jack "b" (C22) in Type Rel 35 W 465 0.8 to 1.2 v AC (21.6 mc/s)?
YES
NO
Check the converter (tube 3) in Type Rel 35 W 465 Is the fault cleared?
NO
Check the cable connecting jack "b" in Type Rel 35 W 465 to the carrier amplifier jack "b" in the power supply unit Type Rel 35 W 467. Is the fault cleared?
NO
Is the voltage at the ceramic lead-through unit "e" in the oscillator subassembly Type Rel 35 W 463 0.4 to 0.65 v AC?
YES
NO
Check the carrier amplifier (tube 1) in the power supply unit Type Rel 35 W 467 (Is the voltage at jack "b" 0.8 to 1.2 v AC?)
NO
Check the power supply unit by reference to Rel str 35 W 467 Is the fault cleared?
NO
Proceed by reference to annexed Fig. 3. Is the fault cleared?
NO
Is the voltage at M13 (Ü4) in Type Rel 35 W 465 0.20 to 0.28 v AC (21.05 mc/s)?
YES
NO
Proceed by reference to annexed Fig. 2 Start at 5
Is the voltage at jack "a" in Type Rel 35 W 465 0.35 to 0.8 v AC?
NO
Check the cable connecting jack "a" in Type Rel 35 W 465 to jack "a" in the interpolation oscillator f2. Is the fault cleared?
YES
NO
Proceed by reference to annexed Fig. 4
YES
Is the voltage at M21 (Ü3) (Rel str 35 W 465) 0.3 to 0.4 v?
NO
Check tube 2 and Gr1. 2. 3. Locate the fault by reference to Rel str 35 W 465. Is the fault cleared?
NO
Proceed by reference to annexed Fig. 2 Start at 5

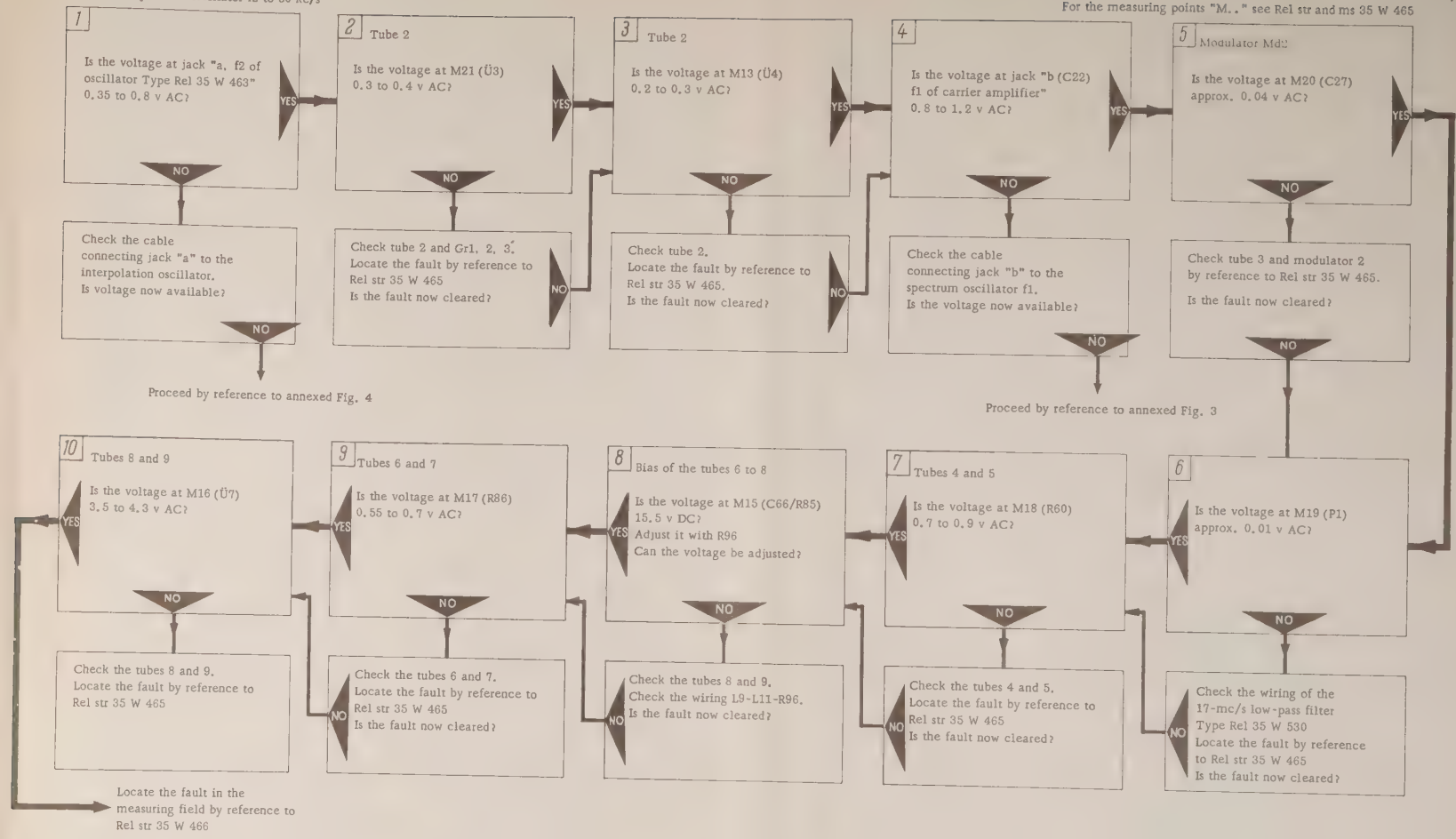
LEVEL OSCILLATOR, LOCATING THE FAULTED SUBASSEMBLY

ANNEXED FIG. 1

SIEMENS
WEITVERKEHRS
TECHNIK

Before starting with the checks,
operate the fine control P1 to the CW stop,
set the spectrum oscillator f1 to 0.5 mc/s,
and the interpolation oscillator f2 to 50 kc/s

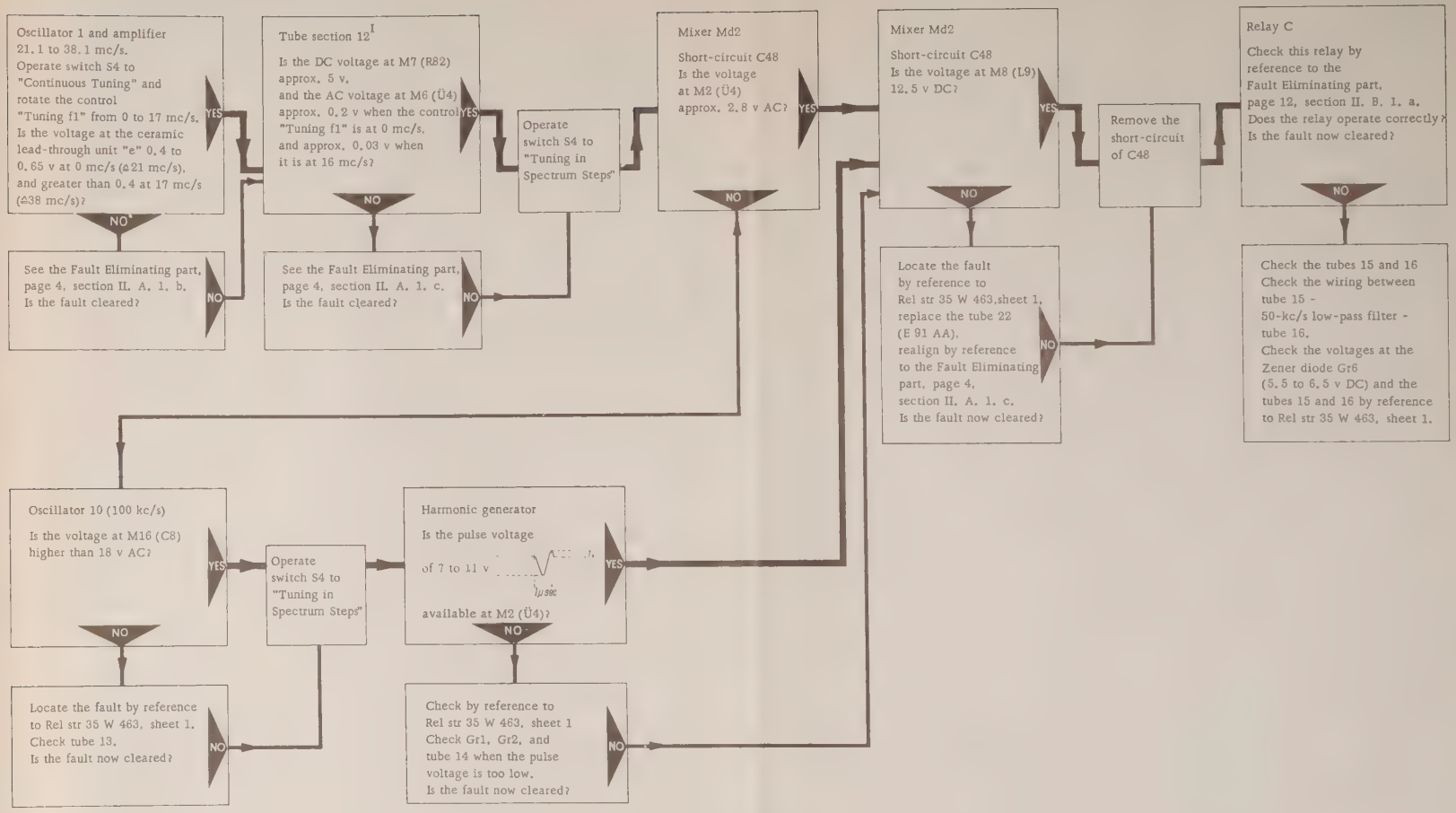
For the measuring points "M.." see Rel str and ms 35 W 465


1
Is the voltage at jack "a, f2 of oscillator Type Rel 35 W 463" 0.35 to 0.8 v AC?
YES
NO
Check the cable connecting jack "a" to the interpolation oscillator. Is voltage now available?
NO
Proceed by reference to annexed Fig. 4
2
Tube 2
Is the voltage at M21 (Ü3) 0.3 to 0.4 v AC?
YES
NO
Check tube 2 and Gr1, 2, 3. Locate the fault by reference to Rel str 35 W 465 Is the fault now cleared?
NO
3
Tube 2
Is the voltage at M13 (Ü4) 0.2 to 0.3 v AC?
YES
NO
Check tube 2. Locate the fault by reference to Rel str 35 W 465. Is the fault now cleared?
NO
4
Is the voltage at jack "b (C22) f1 of carrier amplifier" 0.8 to 1.2 v AC?
YES
NO
Check the cable connecting jack "b" to the spectrum oscillator f1. Is the voltage now available?
NO
Proceed by reference to annexed Fig. 3
5
Modulator Md2
Is the voltage at M20 (C27) approx. 0.04 v AC?
YES
NO
Check tube 3 and modulator 2 by reference to Rel str 35 W 465. Is the fault now cleared?
NO
6
Is the voltage at M19 (P1) approx. 0.01 v AC?
YES
NO
Check the wiring of the 17-mc/s low-pass filter Type Rel 35 W 530 Locate the fault by reference to Rel str 35 W 465 Is the fault now cleared?
NO
7
Tubes 4 and 5
Is the voltage at M18 (R60) 0.7 to 0.9 v AC?
YES
NO
Check the tubes 4 and 5. Locate the fault by reference to Rel str 35 W 465 Is the fault now cleared?
NO
8
Bias of the tubes 6 to 8
Is the voltage at M15 (C66/R85) 15.5 v DC? Adjust it with R96 Can the voltage be adjusted?
YES
NO
Check the tubes 8 and 9. Check the wiring L9-L11-R96. Is the fault now cleared?
NO
9
Tubes 6 and 7
Is the voltage at M17 (R86) 0.55 to 0.7 v AC?
YES
NO
Check the tubes 6 and 7. Locate the fault by reference to Rel str 35 W 465 Is the fault now cleared?
NO
10
Tubes 8 and 9
Is the voltage at M16 (Ü7) 3.5 to 4.3 v AC?
YES
NO
Check the tubes 8 and 9. Locate the fault by reference to Rel str 35 W 465
Locate the fault in the measuring field by reference to Rel str 35 W 466

LEVEL OSCILLATOR, CHECKING THE MODULATOR AND AMPLIFIER SUBASSEMBLY

ANNEXED FIG. 2

For the measuring points "M.." see Rel str 35 W 463, sheet 1
and Rel ms 35 W 463

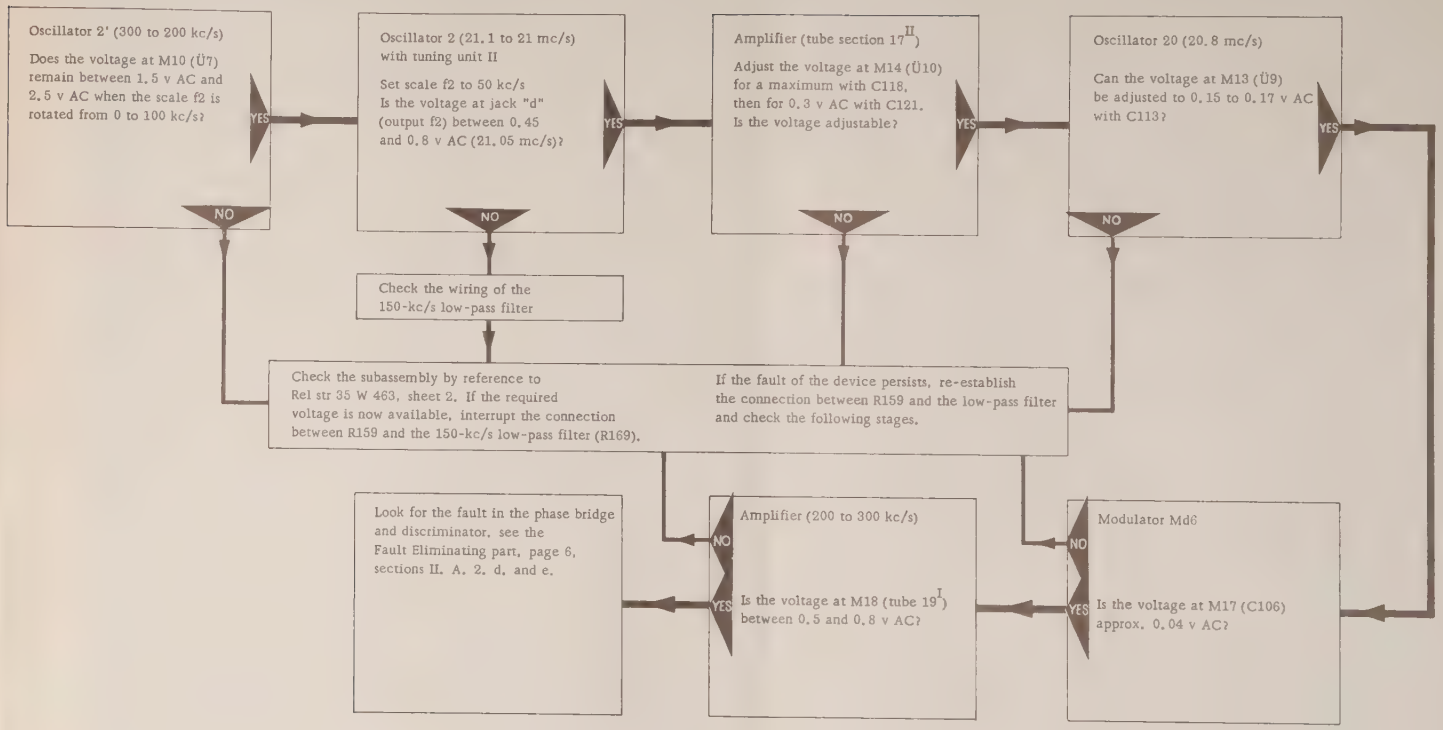

Oscillator 1 and amplifier
21.1 to 38.1 mc/s.
Operate switch S4 to "Continuous Tuning" and rotate the control "Tuning f1" from 0 to 17 mc/s.
Is the voltage at the ceramic lead-through unit "e" 0.4 to 0.65 v at 0 mc/s (≙21 mc/s), and greater than 0.4 at 17 mc/s (≙38 mc/s)?
YES
NO
See the Fault Eliminating part, page 4, section II. A. 1. b.
Is the fault cleared?
NO
Tube section 12I
Is the DC voltage at M7 (R82) approx. 5 v, and the AC voltage at M6 (Ü4) approx. 0.2 v when the control "Tuning f1" is at 0 mc/s, and approx. 0.03 v when it is at 16 mc/s?
YES
NO
See the Fault Eliminating part, page 4, section II. A. 1. c.
Is the fault cleared?
NO
Operate switch S4 to "Tuning in Spectrum Steps"
Mixer Md2
Short-circuit C48
Is the voltage at M2 (Ü4) approx. 2.8 v AC?
YES
NO
Mixer Md2
Short-circuit C48
Is the voltage at M8 (L9) 12.5 v DC?
YES
NO
Locate the fault by reference to Rel str 35 W 463, sheet 1, replace the tube 22 (E 91 AA), realign by reference to the Fault Eliminating part, page 4, section II. A. 1. c.
Is the fault now cleared?
NO
Remove the short-circuit of C48
Relay C
Check this relay by reference to the Fault Eliminating part, page 12, section II. B. 1. a.
Does the relay operate correctly?
Is the fault now cleared?
NO
Check the tubes 15 and 16
Check the wiring between tube 15 - 50-kc/s low-pass filter - tube 16.
Check the voltages at the Zener diode Gr6 (5.5 to 6.5 v DC) and the tubes 15 and 16 by reference to Rel str 35 W 463, sheet 1.
Oscillator 10 (100 kc/s)
Is the voltage at M16 (C8) higher than 18 v AC?
YES
NO
Locate the fault by reference to Rel str 35 W 463, sheet 1.
Check tube 13.
Is the fault now cleared?
NO
Operate switch S4 to "Tuning in Spectrum Steps"
Harmonic generator
Is the pulse voltage
of 7 to 11 v
1 µsec
available at M2 (Ü4)?
YES
NO
Check by reference to Rel str 35 W 463, sheet 1
Check Gr1, Gr2, and tube 14 when the pulse voltage is too low.
Is the fault now cleared?
NO

LEVEL OSCILLATOR, CHECKING THE SPECTRUM OSCILLATOR f_1

ANNEXED FIG. 3

Before starting with this check, connect the wiper of the potentiometer R159 (M9) to the input of the 150-kc/s low-pass filter. This connection is retained until the end of the testing procedure.

For the measuring points "M.." see Rel str 35 W 463, sheet 2 and Rel ms 35 W 463


Oscillator 2' (300 to 200 kc/s)
Does the voltage at M10 (Ü7) remain between 1.5 v AC and 2.5 v AC when the scale f2 is rotated from 0 to 100 kc/s?
YES
NO
Oscillator 2 (21.1 to 21 mc/s) with tuning unit II
Set scale f2 to 50 kc/s
Is the voltage at jack "d" (output f2) between 0.45 and 0.8 v AC (21.05 mc/s)?
YES
NO
Amplifier (tube section 17II)
Adjust the voltage at M14 (Ü10) for a maximum with C118, then for 0.3 v AC with C121.
Is the voltage adjustable?
YES
NO
Oscillator 20 (20.8 mc/s)
Can the voltage at M13 (Ü9) be adjusted to 0.15 to 0.17 v AC with C113?
YES
NO
Check the wiring of the 150-kc/s low-pass filter
Check the subassembly by reference to Rel str 35 W 463, sheet 2. If the required voltage is now available, interrupt the connection between R159 and the 150-kc/s low-pass filter (R169).
If the fault of the device persists, re-establish the connection between R159 and the low-pass filter and check the following stages.
Look for the fault in the phase bridge and discriminator, see the Fault Eliminating part, page 6, sections II. A. 2. d. and e.
Amplifier (200 to 300 kc/s)
NO
YES
Is the voltage at M18 (tube 19I) between 0.5 and 0.8 v AC?
Modulator Md6
NO
YES
Is the voltage at M17 (C106) approx. 0.04 v AC?

LEVEL OSCILLATOR, CHECKING THE INTERPOLATION OSCILLATOR f_2

ANNEXED FIG. 4

SIEMENS
WEITVERKEHRS
TECHNIK

Before starting with the check set the following on the level meter:
operate the control "Tuning f1" to 0.5 mc/s,
the control "Tuning f2" to 0 kc/s,
the calibrating control "P" to the CCW stop,
the level range switch S3 to the position 0 db (0 N),
the function switch S4 to "Pass Band 2 kc/s with Tuning in Spectrum Steps",
inactivate the key "Reading -20 db (-2 N)" (the lamp must be dark),
or operate switch S7 to 0 db (models e...)

Note. The applied signal frequencies of 550 kc/s, 21 mc/s, and 1.5 mc/s must be within the pass band of the following filters. Therefore, in these measurements, adjust the applied frequency so that the level meter reading is maximized.

For the signal feed-in and measuring points see Rel str/ms 35 D 340 and Rel str/ms 35 D 330

Apply a signal f = 500 kc/s, n = -50 to -55 db (-5.8 N to -6.3 N) at L4 - R5* (ceramic lead-through unit at the 17-mc/s low-pass filter Type Rel 35 D 420)

Is the meter indication within the upper third of the scale or higher?

NO → Inject a signal f = 21 mc/s, approx. 0.8 to 1 v, to C35 - C32 - L10* The level oscillator Type Rel 3 W 518 delivers this voltage to the output "Synchr. f1" if the frequency scale f1 is at the first spectrum point below the 0-mc/s mark.

Is the meter indication within the upper third of the scale or higher?

NO → Apply a signal f = 1.5 mc/s, n = -60 db (-7 N) to Ü6, soldering lug 3*

Does the instrument read about full scale?

NO → Proceed by reference to the annexed Fig. 6

YES

Apply a signal f = 500 kc/s, n = -50 to -55 db (-5.8 N to -6.3 N) to C17 - R15 (preamplifier input in the measuring field, see Rel str 35 D 330)

Is the meter indication within the upper third of the scale or higher?

NO → Check the tubes 1 and 2 in the preamplifier. Locate the fault by reference to Rel str 35 D 330. Adjust the voltage at M28 (tube 2, Rel str 35 D 330) for 27 v with R13.

Is the fault now cleared?

NO → Check the input divider Type Rel 35 D 365 and the Z-switch in the measuring field Type Rel 35 D 330 for short-circuits and broken leads.

Is the fault now cleared?

NO → Check the power supply unit Type Rel 35 D 331 by reference to Rel str 35 D 331

YES

Is the voltage at the input f1, jack "d", 0.8 to 1.2 v (21.6 mc/s)?

YES → Check the wiring of modulator 1 and the 21-mc/s band-pass filter for short-circuits and broken leads. Check the crystal diodes Gr1 to Gr4 for their forward and inverse resistances.

NO

Is the voltage at jack "c" of the carrier amplifier output in the measuring field Type Rel 35 D 330 0.8 to 1.2 v (21.6 mc/s)?

YES → Check the cable connecting jack "c" (carrier amplifier output in the measuring field) to jack "d" (input f1 in the superheterodyne unit Type Rel 35 D 340)

NO

Is the voltage at jack "b" of the carrier amplifier input (Rel str 35 D 330) approx. 0.9 v AC (21.6 mc/s)?

NO → Check the cable connecting jack "b" (carrier amplifier input) to jack "c" (in the oscillator subassembly Type Rel 35 D 328). Is the fault cleared?

NO → Proceed by reference to annexed Fig. 7

YES

Check tube 3 in the carrier amplifier. Locate the fault by reference to Rel str 35 D 330

YES

Is the voltage at input f2, jack "c" 0.4 to 0.9 v AC (19.6 mc/s)?

YES → Check the wiring of modulator 2 for short-circuits, broken leads, and the crystal diodes of Md2 for their forward and reverse resistances.

Is the fault now cleared?

NO → Check the 21-mc/s amplifier (tube 4) by reference to Rel str 35 D 340. Is the fault now cleared?

NO

NO → Check the cable connecting jack "c" (input f2) to jack "d" (output f2 in the oscillator subassembly Type Rel 35 D 328)

NO → Proceed by reference to the annexed Fig. 8

*For the measuring setup and the applied levels see annexed Fig. 6

LEVEL METER, LOCATING THE FAULTED SUBASSEMBLY

ANNEXED FIG. 5

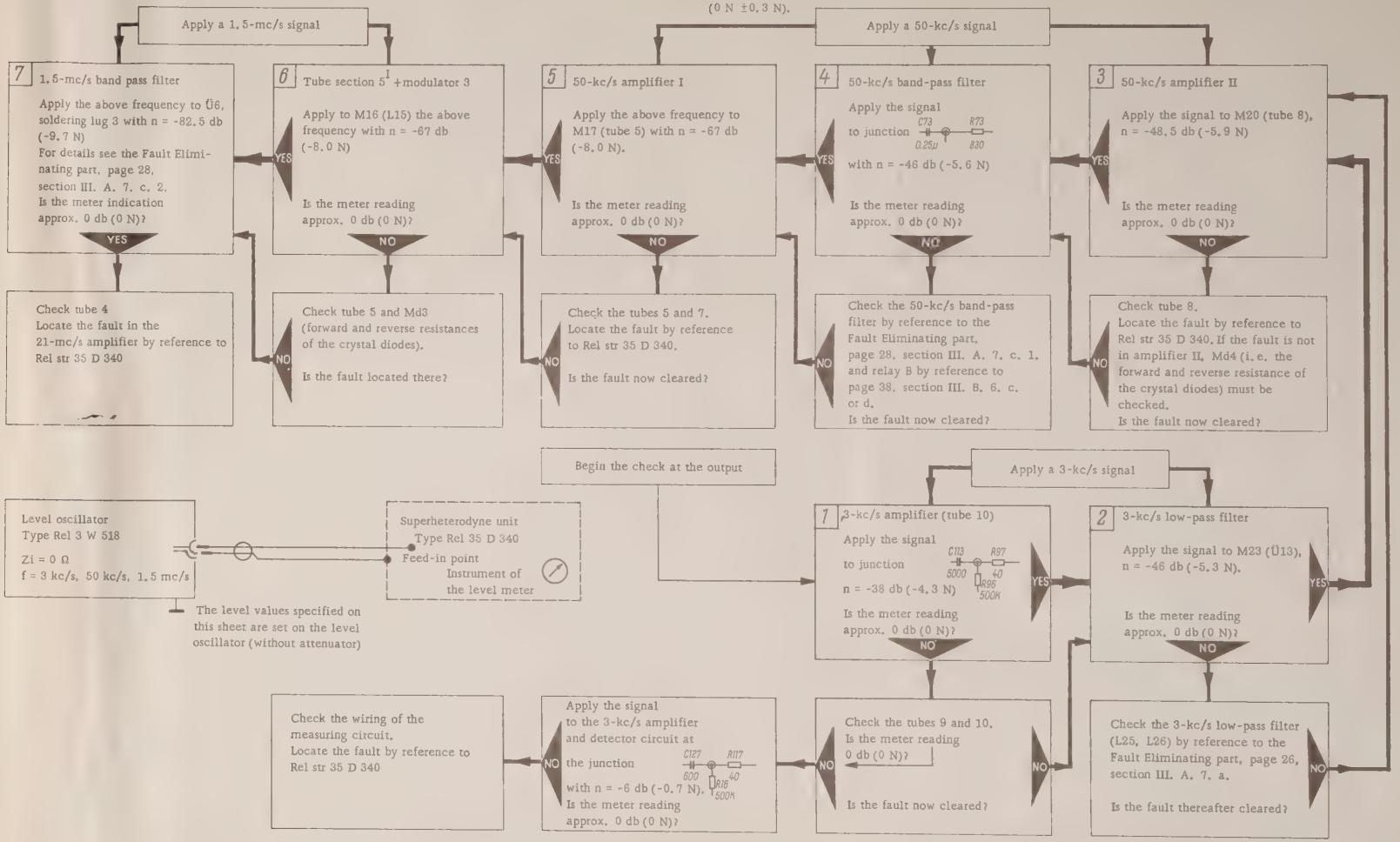
Make the following settings on the level meter:
Operate the control "Tuning f1" to 0.5 mc/s,
the control "Tuning f2" to 50 kc/s,
and the calibrating control "P" to the CW stop.
Operate the level range switch S3 to the most sensitive position (CW stop).

Operate the function switch S4 to "Pass Band 2 kc/s with Tuning in Spectrum Steps"
Operate the key "Reading -20 db/-2 N" to "Off" (lamp is dark), or, in the case of the models "e", operate switch S7 to 0 db (0 N).

Note. The applied frequencies of 50 kc/s and 1.5 mc/s must be within the pass band of the following filters. Therefore, in these measurements, adjust the applied frequency so that the instrument reading is maximized with application of the specified levels, the meter must read 0 db ±3 db (0 N ±0.3 N).

For the signal feed-in and measuring points see Rel str/ms 35 D 340

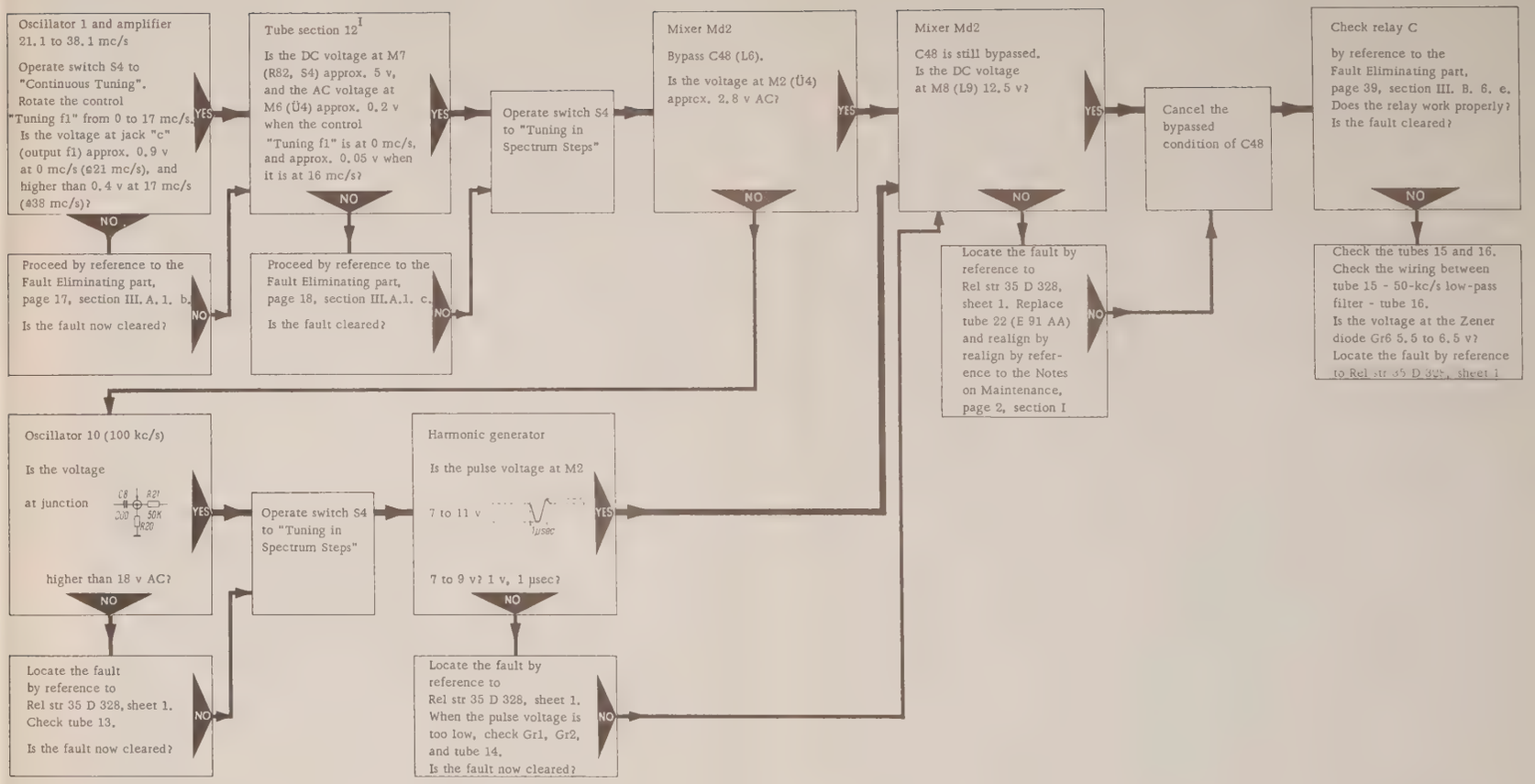
SIEMENS WEITVERKEHRS TECHNIK


Apply a 1.5-mc/s signal
Apply a 50-kc/s signal
7 1.5-mc/s band pass filter
Apply the above frequency to Ü6, soldering lug 3 with n = -82.5 db (-9.7 N)
For details see the Fault Eliminating part, page 28, section III. A. 7. c. 2.
Is the meter indication approx. 0 db (0 N)?
YES
6 Tube section 5I+modulator 3
Apply to M16 (L15) the above frequency with n = -67 db (-8.0 N)
Is the meter reading approx. 0 db (0 N)?
NO
5 50-kc/s amplifier I
Apply the above frequency to M17 (tube 5) with n = -67 db (-8.0 N).
Is the meter reading approx. 0 db (0 N)?
NO
4 50-kc/s band-pass filter
Apply the signal to junction C73 0.25µ R73 830
with n = -46 db (-5.6 N)
Is the meter reading approx. 0 db (0 N)?
NO
3 50-kc/s amplifier II
Apply the signal to M20 (tube 8), n = -48.5 db (-5.9 N)
Is the meter reading approx. 0 db (0 N)?
NO
Check tube 4
Locate the fault in the 21-mc/s amplifier by reference to Rel str 35 D 340
Check tube 5 and Md3 (forward and reverse resistances of the crystal diodes).
Is the fault located there?
Check the tubes 5 and 7.
Locate the fault by reference to Rel str 35 D 340.
Is the fault now cleared?
Check the 50-kc/s band-pass filter by reference to the Fault Eliminating part, page 28, section III. A. 7. c. 1. and relay B by reference to page 38, section III. B. 6. c. or d.
Is the fault now cleared?
Check tube 8.
Locate the fault by reference to Rel str 35 D 340. If the fault is not in amplifier II, Md4 (i.e. the forward and reverse resistance of the crystal diodes) must be checked.
Is the fault now cleared?
Begin the check at the output
Apply a 3-kc/s signal
Level oscillator
Type Rel 3 W 518
Zi = 0 Ω
f = 3 kc/s, 50 kc/s, 1.5 mc/s
Superheterodyne unit
Type Rel 35 D 340
Feed-in point
Instrument of the level meter
The level values specified on this sheet are set on the level oscillator (without attenuator)
1 3-kc/s amplifier (tube 10)
Apply the signal to junction C113 5000 R87 40 R86 500K
n = -38 db (-4.3 N)
Is the meter reading approx. 0 db (0 N)?
2 3-kc/s low-pass filter
Apply the signal to M23 (Ü13), n = -46 db (-5.3 N).
Is the meter reading approx. 0 db (0 N)?
Check the wiring of the measuring circuit.
Locate the fault by reference to Rel str 35 D 340
Apply the signal to the 3-kc/s amplifier and detector circuit at the junction C127 600 R117 40 R16 500K
with n = -6 db (-0.7 N).
Is the meter reading approx. 0 db (0 N)?
Check the tubes 9 and 10.
Is the meter reading 0 db (0 N)?
Is the fault now cleared?
Check the 3-kc/s low-pass filter (L25, L26) by reference to the Fault Eliminating part, page 26, section III. A. 7. a.
Is the fault thereafter cleared?

LEVEL METER, CHECKING THE SUPERHETERODYNE UNIT

ANNEXED FIG. 6

For the measuring points "M.." see Rel str 35 D 328, sheet 1
and Rel ms 35 D 328

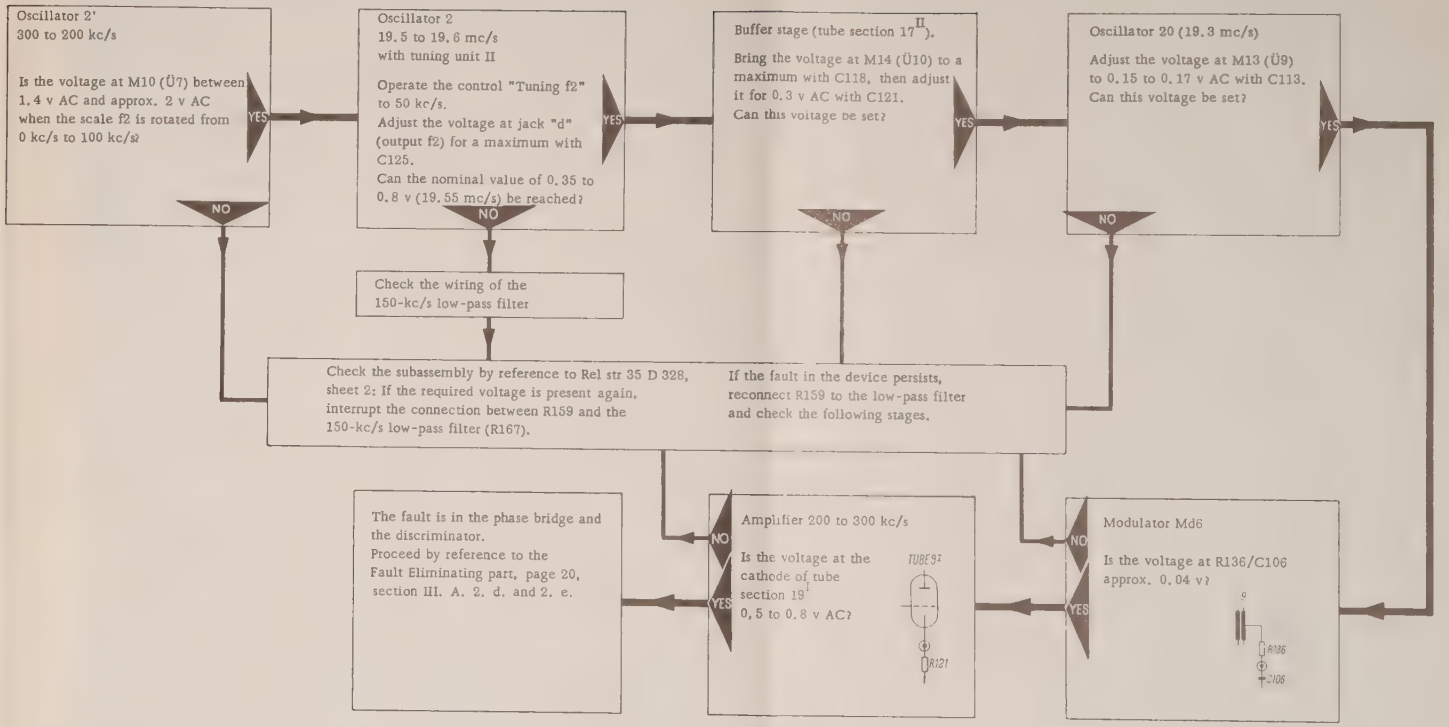

Oscillator 1 and amplifier
21.1 to 38.1 mc/s
Operate switch S4 to "Continuous Tuning". Rotate the control "Tuning f1" from 0 to 17 mc/s. Is the voltage at jack "c" (output f1) approx. 0.9 v at 0 mc/s (≙21 mc/s), and higher than 0.4 v at 17 mc/s (≙38 mc/s)?
YES
NO
Proceed by reference to the Fault Eliminating part, page 17, section III. A. 1. b.
Is the fault now cleared?
NO
Tube section 12I
Is the DC voltage at M7 (R82, S4) approx. 5 v, and the AC voltage at M6 (Ü4) approx. 0.2 v when the control "Tuning f1" is at 0 mc/s, and approx. 0.05 v when it is at 16 mc/s?
YES
NO
Proceed by reference to the Fault Eliminating part, page 18, section III.A.1. c.
Is the fault cleared?
NO
Operate switch S4 to "Tuning in Spectrum Steps"
Mixer Md2
Bypass C48 (L6).
Is the voltage at M2 (Ü4) approx. 2.8 v AC?
YES
NO
Mixer Md2
C48 is still bypassed.
Is the DC voltage at M8 (L9) 12.5 v?
YES
NO
Locate the fault by reference to Rel str 35 D 328, sheet 1. Replace tube 22 (E 91 AA) and realign by realign by reference to the Notes on Maintenance, page 2, section I
NO
Cancel the bypassed condition of C48
Check relay C
by reference to the Fault Eliminating part, page 39, section III. B. 6. e.
Does the relay work properly?
Is the fault cleared?
NO
Check the tubes 15 and 16. Check the wiring between tube 15 - 50-kc/s low-pass filter - tube 16.
Is the voltage at the Zener diode Gr6 5.5 to 6.5 v?
Locate the fault by reference to Rel str 35 D 328, sheet 1
Oscillator 10 (100 kc/s)
Is the voltage
at junction
C8 221 200 50K R20
higher than 18 v AC?
YES
NO
Locate the fault by reference to Rel str 35 D 328, sheet 1. Check tube 13.
Is the fault now cleared?
NO
Operate switch S4 to "Tuning in Spectrum Steps"
Harmonic generator
Is the pulse voltage at M2
7 to 11 v
1 µsec
7 to 9 v? 1 v, 1 µsec
YES
NO
Locate the fault by reference to Rel str 35 D 328, sheet 1. When the pulse voltage is too low, check Gr1, Gr2, and tube 14.
Is the fault now cleared?
NO

LEVEL METER. CHECKING THE SPECTRUM OSCILLATOR f_1

ANNEXED FIG. 7

Before starting with the checks, connect the wiper of the potentiometer R159 (M9) to the input of the 150-kc/s low-pass filter (R167). This connection is retained until the checking procedure is finished.

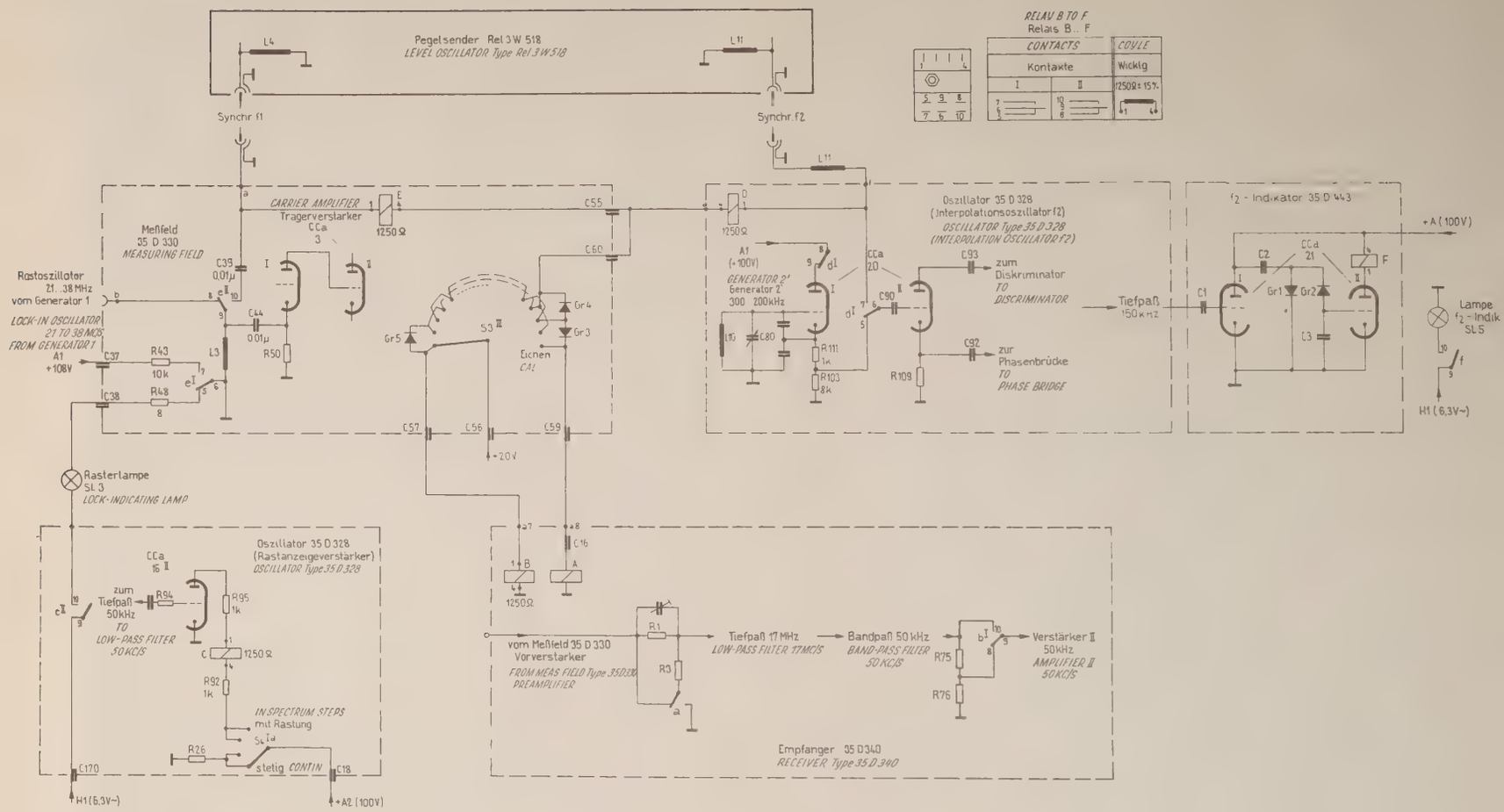
For the measuring points "M.." see Rel str 35 D 328, sheet 2 and Rel ms 35 D 328


Oscillator 2'
300 to 200 kc/s
Is the voltage at M10 (Ü7) between 1.4 v AC and approx. 2 v AC when the scale f2 is rotated from 0 kc/s to 100 kc/s?
YES
NO
Oscillator 2
19.5 to 19.6 mc/s
with tuning unit II
Operate the control "Tuning f2" to 50 kc/s.
Adjust the voltage at jack "d" (output f2) for a maximum with C125.
Can the nominal value of 0.35 to 0.8 v (19.55 mc/s) be reached?
YES
NO
Buffer stage (tube section 17II).
Bring the voltage at M14 (Ü10) to a maximum with C118, then adjust it for 0.3 v AC with C121.
Can this voltage be set?
YES
NO
Oscillator 20 (19.3 mc/s)
Adjust the voltage at M13 (Ü9) to 0.15 to 0.17 v AC with C113.
Can this voltage be set?
YES
NO
Check the wiring of the 150-kc/s low-pass filter
Check the subassembly by reference to Rel str 35 D 328, sheet 2: If the required voltage is present again, interrupt the connection between R159 and the 150-kc/s low-pass filter (R167).
If the fault in the device persists, reconnect R159 to the low-pass filter and check the following stages.
The fault is in the phase bridge and the discriminator.
Proceed by reference to the Fault Eliminating part, page 20, section III. A. 2. d. and 2. e.
Amplifier 200 to 300 kc/s
Is the voltage at the cathode of tube section 19I 0,5 to 0.8 v AC?
TUBE 9I
R121
NO
YES
Modulator Md6
Is the voltage at R136/C106 approx. 0.04 v?
R136
C106
NO
YES

LEVEL METER, CHECKING THE INTERPOLATION OSCILLATOR f_2

ANNEXED FIG. 8

SIEMENS
WEITVERKEHRS
TECHNIK



Pegelmesser, Stromlauf-Auszug für die Relaisfunktionen — Bildanlage 9

LEVEL METER, ABRIDGED CIRCUIT DIAGRAM
FOR THE RELAY FUNCTIONS — ANNEXED FIG. 9

Rel beheb 3 W 518d/3 D 335d — 9

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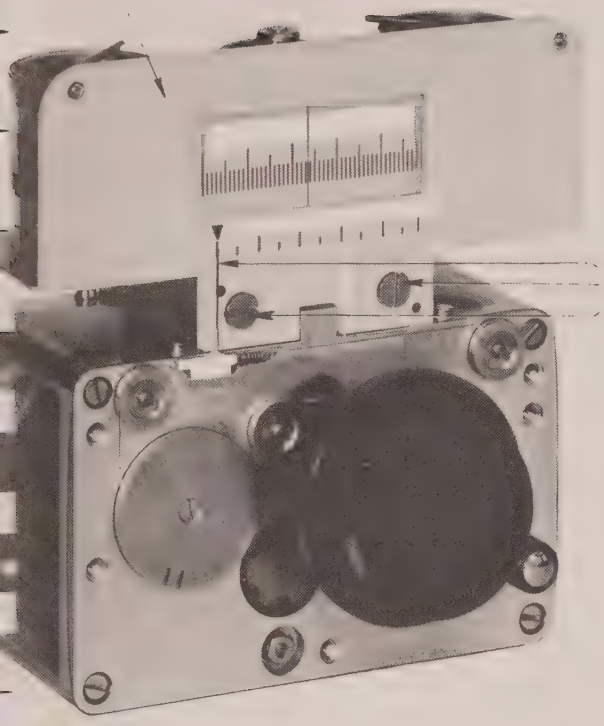
kassette
M MAGAZINE

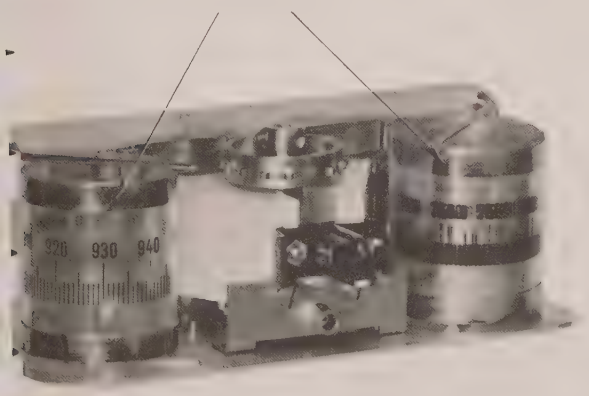


Zum Herausnehmen:
1. Antrieb auf linken Anschlag drehen
2. Zeiger herunterklappen
3. Befestigungsschrauben lösen
4. Filmkassette herausnehmen

FOR REMOVAL
1. ROTATE DRIVE TO CCW STOP
2. TILT DOWN THE INDEX
3. LOOSEN THE FASTENING SCREWS
4. TAKE OUT THE FILM MAGAZINE

nantrieb, Frontschild abgenommen
M DRIVE WITH FRONT PLATE REMOVED

ng! Diese Federn nicht verbiegen
.ION: AVOID BENDING THESE SPRINGS



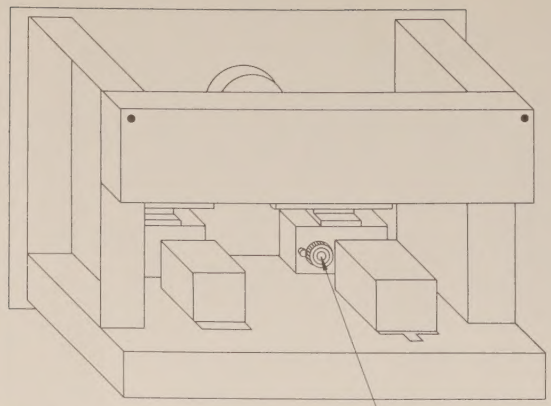
5. Film in der herausgenommenen Kassette von Hand vollständig in die linke Feder einrollen, dabei Federn nicht verbiegen!
6. Eingerollten Film senkrecht aus der Feder herausnehmen.

5. IN THE REMOVED MAGAZINE ROLL THE FILM MANUALLY ALL THE WAY INTO THE LEFT-HAND SPRING AVOID BENDING THE SPRINGS IN THIS PROCEDURE!
6. TAKE OUT THE COILED FILM VERTICALLY FROM THE SPRING.

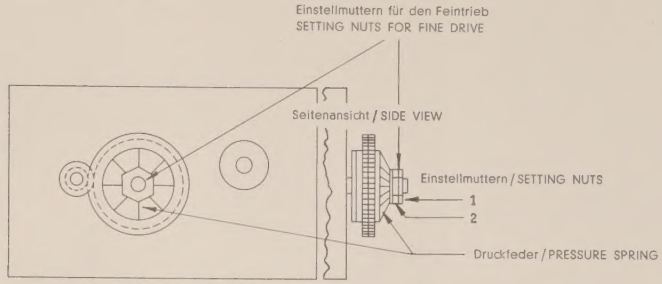
ausgenommene Filmkassette
IOVED FILM MAGAZINE

usnehmen eines Skalenfilms
NG OUT A SCALE FILM

Bildanlage 10
ANNEXED FIG. 10



a. Innenansicht des Geräts
INTERIOR VIEW OF DEVICE



b. Ansicht des Antriebs f_1 ohne Drehkondensator
VIEW TOWARDS DRIVE f_1 WITHOUT VARIABLE CAPACITOR

Nachstellen des Feintriebs:

1. Mutter 1 lösen; Mutter 2 dabei festhalten und Mutter 1 nach links drehen
2. Mutter 2 leicht anziehen (nach rechts drehen), bis der Feintrieb den Film transportiert.
   Nicht zu fest anziehen, da sonst der Grobtrieb zu schwer geht.
3. Mutter 2 — wie nach 2 eingestellt — festhalten und Mutter 1 fest an Mutter 2 anziehen.

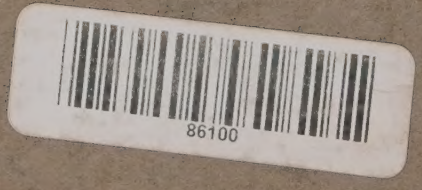
ADJUSTING THE FINE DRINE:

1. LOOSEN NUT 1; WHILE HOLDING NUT 2 AND ROTATING NUT 1 COUNTER-CLOCKWISE.
2. TIGHTEN NUT 2 SLIGHTLY (CLOCKWISE ROTATION) UNTIL FINE DRIVE CATCHES TO TRANSPORT THE FILM. AVOID EXCESSIVE TIGHTENING OR ELSE THE COARSE DRIVE MOVES TO HARD.
3. HOLD NUT 2 IN THE POSITION SET UNDER (2) AND TIGHTEN NUT 1 FIRMLY AGAINST NUT 2.

Nachstellen des Feintriebs f_1
ADJUSTING THE FINE DRIVE f_1

Bildanlage 11
ANNEXED FIG. 11

FAULT LOCATING, FAULT ELIMINATING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